I T H E A

International Journal

INFORMATION TECHNOLOGIES & KNOWLEDGE

2018 Volume 12 Number 3

International Journal
INFORMATION TECHNOLOGIES & KNOWLEDGE

Volume 12 / 2018, Number 1

International Journal “INFORMATION TECHNOLOGIES & KNOWLEDGE” (IJ ITK) is official publisher of the scientific papers of the members of the ITHEA International Scientific Society. IJ ITK rules for preparing the manuscripts are compulsory. The **rules for the papers** for IJ ITK are given on www.ithea.org

Responsibility for papers published in IJ ITK belongs to authors.

International Journal “INFORMATION TECHNOLOGIES & KNOWLEDGE” Volume 12, Number 3, 2018

Edited by the **Institute of Information Theories and Applications FOI ITHEA**, Bulgaria, in collaboration with: University of Telecommunications and Posts, Bulgaria, V.M.Glushkov Institute of Cybernetics of NAS, Ukraine, Universidad Politécnica de Madrid, Spain, Hasselt University, Belgium, University of Perugia, Italy, Institute for Informatics and Automation Problems, NAS of the Republic of Armenia St. Petersburg Institute of Informatics, RAS, Russia,

Printed in Bulgaria

Publisher ITHEA®

Sofia, 1000, P.O.B. 775, Bulgaria. www.ithea.org, e-mail: info@foibg.com

Technical editor: Ina Markova

Издател: ИТЕА®, София 1000, ПК 775, България, www.ithea.org, e-mail: info@foibg.com

ISSN 1313-0455 (printed) **ISSN 1313-048X (online)**

NEW APPROACHES TO THE SCHOOL SCHEDULING AUTOMATION

Zainab Saadi Hussein Al-Hilali, Volodymyr Shevchenko

***Abstract**: An innovative approach was applied to the scheduling problem. Scheduling is a resource-consuming task in any field. School Learning Management Systems lack this functionality for off-line classes. The solution could help to account the working time of the staff simpler and, primarily, to construct the weekly school classes schedule, which complies with the requirements and limitations of the school and teaching process, with less effort. In this paper, we adopted approaches from another area of workforce management to this significant task. We also developed the software solution, which solves this issue and implements the scheduling for classes in a school or university, considering requirements, limitations, and input wishes. The results quality was evaluated via experiments because of strong practical interest in the task and showed objective validity.*

The focus of this work is the scheduling task and innovative solution developed, which seems to be valuable for the community.

***Keywords**: e-learning, scheduling, learning management system, school management.*

***ITHEA Keywords**:* J.1 Computer Applications - ADMINISTRATIVE DATA PROCESSING - Education, K.3.1 Computing Milieux - COMPUTERS AND EDUCATION - Computer Uses in Education, I.2.8 Computing Methodologies - ARTIFICIAL INTELLIGENCE - Problem Solving, Control Methods, and Search - Scheduling, H.4.1 Information Systems - INFORMATION SYSTEMS APPLICATIONS - Office Automation - Time management (e.g., calendars, schedules), F.2.2 Theory of Computation - ANALYSIS OF ALGORITHMS AND PROBLEM COMPLEXITY - Nonnumerical Algorithms and Problems - Sequencing and scheduling

Introduction

Learning Management Systems (LMS) are very popular today, also known as e-Learning systems (like Moodle and others). They cover many functions concerning the study itself and the learning process organization:

- student progress tracking throughout the classes (disciplines) and the whole learning curve,
- communication with teachers,
- learning material arrangement,
- homework assignments to the students,
- additional functions.

The scheduling is a crucial and challenging task in many fields. Time-tables creation for workforce management in organizations is one of the vital stability factors for Contact Centers and other companies with shift-based work organization [Chernichenko, 2016; Lytvynenko, 2015; Panchenko, 2003; Panchenko2, 2003; Panchenko, 2004; Apex, 2008].

As to the schools and universities, the schedule of classes is one of the crucial documents, which directs the whole teaching process. We have the following inputs:

- requirements – the workload of each teacher (or professor), how many hours of which kind of classes he/she should deliver per week,
- wishes – which days and time are preferred by workers, or not possible at all for them because of another kind of business or activities,
- sites – classrooms of different types for each class,
- limitations – which classes could be sequent, which one should go first, next and last, the upper limit of classes per day, the limit of lectures per day.

Also, in the case of school or university schedule, a necessary additional requirement of interchangeability (or, a kind of flexibility in the sense of change management) should be considered. We mean that changes should be possible to make on request without extra overhead for the scheduling manager (for example, to find another teacher or professor for the particular class or to move some class to another day of week and time – for one time or on a regular basis).

So, we consider the task of delivering the schedule, which meets all the requirements above. This functionality can be rarely found in systems aimed to support the learning process, namely LMS [Hilali, 2015; Hilali, 2016; Aggarwal, 2018; Nagar, 2018; Nawaz, 2012; Shariat, 2014; Eljinini, 2012; Maysam, 2012; Muhsen, 2013; Guangran, 2011; Pishva, 2013; Inayat, 2013; Dominic, 2014; Dominic, 2015; Dominic2, 2015; Kocaleva, 2015; Marikar, 2016; Dushyanthi, 2016; Shili, 2017; Okey, 2019; Dada, 2019; Adejo, 2018; Akinul, 2017; Deogratius, 2018; Robles, 2017]. It was out of the scope of these systems in most cases, because this kind of systems is more about on-line (instead of off-line, in-class) education. Even when this function exists, it is presented mostly as just a calendar (for flexible manual planning) or as a separate product. It requires much integration efforts for the next regular use. Manual schedule adjustment and tuning is a time-consuming process because it is hard to take into account all the limitations at once. If the process is not automatized, it requires much attention and iterations to comply with all the needs posted above. Nevertheless, this question is not well presented in recent papers concerning LMS and e-Learning [Hilali, 2015; Hilali, 2016; Aggarwal, 2018; Nagar, 2018; Nawaz, 2012; Shariat, 2014; Eljinini, 2012; Maysam, 2012; Muhsen, 2013; Guangran, 2011; Pishva, 2013; Inayat, 2013; Dominic, 2014; Dominic, 2015; Dominic2, 2015; Kocaleva, 2015; Marikar, 2016; Dushyanthi, 2016; Shili, 2017; Okey, 2019; Dada, 2019; Adejo, 2018; Akinul, 2017; Deogratius, 2018; Robles, 2017].

Scheduling automation will help to solve four sub-tasks at once:

- schedule generation itself,
- change management (with some additional effort),

- accurate accounting of staff working hours,
- reporting of the actual time spending, including shifted and interchanged classes and other cases, which have been fixed in the system during the changes.

Here we tried different new approaches (taken from other areas) to the scheduling task for schools and implemented it in the developed software. As this task is avoided mainly in existing LMS (scheduling automation), the design purpose is to automate this kind of activity to:

- create schedule fast and in accordance with the requirements and limitations set,
- provide an effective software user interface for the next changes management,
- minimize the integration and customization efforts for regular usage.

In this way, we cover the significant task of the LMS, the planning, and scheduling. The research objective of this paper is to check via the experiment if the schedule can be obtained in the suggested way and if that schedule is viable enough. The methodology is the feedback analysis after the experiment – namely, the implementation of the new approach proposed to the school scheduling. It shows the practical value of the proposed innovative approach.

In the next sections, we will overview the existing approaches, emphasizing the methods chosen for our task (namely, methods used for the workforce scheduling), giving more specifics on the proposed solution, and then discussing the outcomes and the future work.

Approaches to the Scheduling

There exist a number of approaches to schedule construction. The choice depends mostly on the filed specifics. So, for example, CPU scheduling differs a lot from WorkForce Management (WFM), which schedules shifts for the working staff of the organization. Markov processes, “brute force” algorithms, optimized search algorithms, genetic algorithms have been applied to generate the schedules as usual [Panchenko, 2003; Panchenko2, 2003; Panchenko, 2004; Apex, 2008]. Machine learning methods [Panchenko, 2003; Panchenko2, 2003;] and gradient descent methods also could be applied here, and we will try to improve the schedule flexibility by introducing an innovative method to the generation process.

“Brute force” algorithms were the most popular because of their simplicity, but they required much computation time. For the large inputs (more than 100 staff, many different activities – classes, non-unit assignment or correspondence matrix of classes – teachers/professors), the process can become incomputable in real-time without supercomputing power. Because of this fact, many optimization techniques and heuristics appear, which help to decrease the computation power required and to sort out just the right cases due to a set of predesigned heuristics. More of this, a kind of gradient descent optimizations were applied to decrease the “brute force” techniques even more. Nowadays, new technics appear like pervasive Artificial Neural Networks (ANN) and other machine learning methods.

The goal is to produce the schedule, which complies with the input requirements and limitations at most, and also is flexible enough for the next change management process. Of course, this kind of flexibility implies extra resources availability. We mean that we should have:

- extra teacher(s), who can provide the same specific class (say, mathematics for 5th-grade pupils) to support another teacher, who should deliver that particular class but cannot come for some reason,
- extra classrooms to make it possible to move classes in time,

The convenient visual tool to support such kind of changes, and to visualize the consequences of changes made, is also a must.

Scheduling Solution Proposed

We started our development on the fundament of the WFM system, which turned out to be similar to the required one. WFM Scheduling solves the task of putting workers (contact center operators) to the shifts, where the shift-based schedule is obtained from the previous stage of planning the resources and forecasting the quantity of the staff at every particular time of the week [Panchenko, 2003; Panchenko2, 2003; Panchenko, 2004; Apex, 2008]. (Time periods are usually hours, half-of-hours or quarter-of-hours.)

We used both “optimized brute force” (modeling a mass service) and “minimization of the energy” methods [Panchenko, 2003; Panchenko2, 2003; Panchenko, 2004]. Both methods are described in [Panchenko, 2003; Panchenko2, 2003; Panchenko, 2004], so we will not go into details here. The latter is based on the idea, which is widely used in many areas for modeling today and is rooted in physics. It is about the probability distribution of final positions of falling metal particles over the magnetic field. In scheduling, this tries to build the most appropriate schedule at first try, and then make improvements to comply with requirements denied in an iterative manner. The number of iterations can grow if the requirements are inconsistent or have a small intersection.

The input requirements and approaches to complete the schedule for two fields under consideration are much different at first glance but turned out to be very similar indeed.

This scheduler is used as a part of the LMS (which is under construction now), or as a separate part (with light integration via the proposed API to export the inputs for the scheduler and to import the resulting schedule) as presented on **Fig. 1**. The API call takes input parameters for the schedule and returns the resulting completed schedule (now in XML and JSON formats).

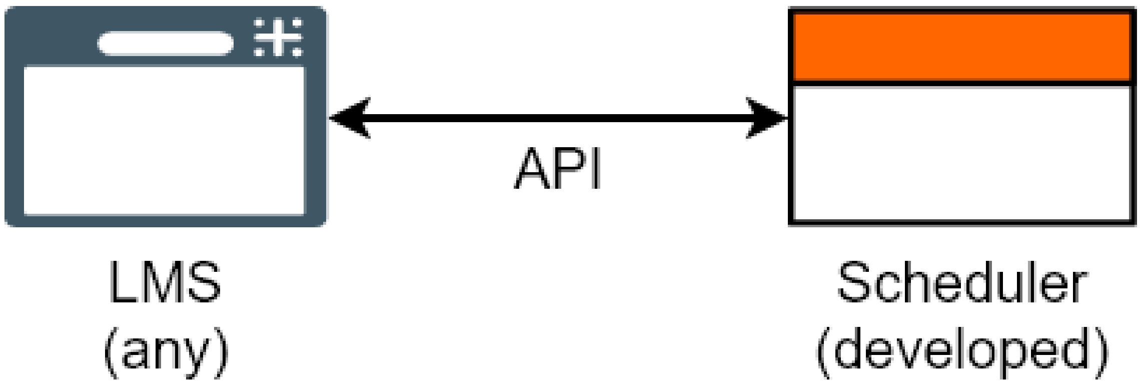


Fig. 1. Scheduler module integration with LMS via API

So, here we proposed to use WFM scheduling ideas for the school schedule completion. We summarize the results and discuss them in the next section.

Experiment Results and Discussion

We developed the new software on the principles of the scheduling for the workforce. For the development of MVP (minimum viable product), we used both variants of algorithms, and it seems that both gives acceptable results. This scheduler is a part of the LMS, which is under development now and is implemented in trial mode in 2 Iraq schools. Now we collect feedbacks to improve the system and move on to the development of the new planned features.

- The main modules of the developed system are:
- scheduler,
- schedule viewer for different roles: teacher, class timetable, classroom load,
- change management support subsystem,
- API for integration with external content management system (LMS),
- API for data exchange (inputs, outputs).

The first feedbacks for the system are positive, so we continue to develop it further.

We leave search optimizations of algorithms for future developments. Also, we are going to try current machine learning techniques, which are also promising for the scheduling task – namely, simple artificial neural nets (trained over the large schedule examples database, which should be collected first), transfer learning techniques, and probably more sophisticated methods subject to its adequacy. These methods are promising for increasing flexibility of the resulting schedule, to simplify the next changes management.

So, here we applied WFM scheduling methods [Panchenko, 2003; Panchenko2, 2003; Panchenko, 2004] to solve the school weekly class scheduling task. It is the main result of the paper. Furthermore, no mention could be found of a similar application in the literature.

Conclusion

In this paper, we investigated the problem of scheduling for the School Management System (or LMS) and proposed our solution to solve it. We articulated that change management is also an essential part of the system.

The main academic contribution of this work is WFM scheduling methods adaptation and application to the school weekly class scheduling task solution.

The innovation of the proposed approach is to use workforce scheduling methods (designed for WFM solutions) to the field of school/university scheduling, which was not evident for obtaining the fair result at first glance. There is no other mention of such methods applications in the literature.

The scheduling task is significant as it takes much time for manual work and has substantial practical importance. So, we are evaluating the results by experiments.

We developed the scheduling solution (based on the “optimized brute force” and “minimization of the energy” algorithms), which helps the managing staff to generate schedules accordingly to the input requirements, limitations, and wishes. Thus, a novel approach (previously used for the contact center scheduling in WFM systems) was applied to the class scheduling task for the school/university environment.

Now, this system is in use by two Iraq schools, and we are gathering feedbacks for the next development, optimization, and other improvements. This system is web-based and provides authorized access for members only according to the role granted. It is developed using modern Microsoft.Net technologies at the back-end and has a front-end client – browser with JavaScript.

The first feedbacks are positive enough and show us that this additional functionality is on demand by the users, giving us the background for the further development and improvement of the system because we solve the important task for users. So, we can conclude that the quality of the obtained results is expectedly high.

Plans include the implementation of more sophisticated approaches to deliver the schedule in a more optimal way (concerning resources required to complete the task). Also, we are going to adopt Artificial Intelligence and Machine Learning approaches mentioned in the paper to make results even better and, possibly, to decrease the time needed for this.

We would like to make the software more user-friendly and adaptive for the different types of limitations to the schedule. Also, the system needs to be more integrated into the learning process, which implies APIs integration with existing external LMS(es) and open API improvement for external developers who will be interested in additional functionality and modules development.

Bibliography

[Akinul, 2017] Akinul Islam Jony, Md. Sadekur Rahman, Yousuf Mahbubul Islam: ICT in Higher Education: Wiki-based Reflection to Promote Deeper Thinking Levels, International Journal of Modern Education and Computer Science (IJMECS). — 2017. — Vol. 9 — No. 4, pp. 43-49,; DOI: 10.5815/ijmecs.2017.04.05

[Adejo, 2018] Olugbenga W. Adejo, Isaiah Ewuzie, Abel Usoro, Thomas Connolly: E-Learning to m-Learning: Framework for Data Protection and Security in Cloud Infrastructure, International Journal of Information Technology and Computer Science (IJITCS). — 2018. — Vol.10— No.4, pp.1--9; DOI: 10.5815/ijitcs.2018.04.01

[Aggarwal, 2018] Anuj Aggarwal, Rajesh Verma, Ajit Singh: An Efficient Approach for Resource Allocations using Hybrid Scheduling and Optimization in Distributed System, “International Journal of Education and Management Engineering (IJEME)”. — 2018. — Vol. 8 — No.3, pp. 33—42., DOI: 10.5815/ijeme.2018.03.04

[Apex, 2008] Apex Berg Contact Center Consulting: Modelling of Contact Center Work. – 2008. -- 83 p.

[Chernichenko, 2016] K. Chernichenko, A. Kapkanets, T. Panchenko, Contact center load forecasting and operator schedule planning, “Problems of Programming”. — 2016. — No. 2-3, pp. 227--236

[Dada, 2019] Emmanuel G. Dada, Abdulkadir H. Alkali, David O. Oyewola: An Investigation into the Effectiveness of Asynchronous and Synchronous E-learning

Mode on Students' Academic Performance in National Open University (NOUN), Maiduguri Centre, International Journal of Modern Education and Computer Science (IJMECS). — 2019. — Vol. 11 — No.5. -- pp. 54—64, DOI: 10.5815/ijmecs.2019.05.06

[Deogratius, 2018] Deogratius M Lashayo, Md Gapar Md Johar: Preliminary Study on Multi-Factors Affecting Adoption of E-Learning Systems in Universities: A Case of Open University of Tanzania (OUT), International Journal of Modern Education and Computer Science (IJMECS). — 2018. — Vol.10 — No.3, pp. 29 – 37.DOI: 10.5815/ijmecs.2018.03.04

[Dominic, 2014] Maria Dominic, Sagayaraj Francis, Anthony Pilomenraj: E-Learning in Web 3.0, International Journal of Modern Education and Computer Science (IJMECS). — 2014. — Vol.6 — No.2, pp.8 – 14, DOI: 10.5815/ijmecs.2014.02.02

[Dominic, 2015] Maria Dominic, Britto Anthony Xavier, Sagayaraj Francis: A Framework to Formulate Adaptivity for Adaptive e-Learning System Using User Response Theory, International Journal of Modern Education and Computer Science (IJMECS). — 2015. — Vol. 7 — No. 1, pp. 23 – 30; DOI: 10.5815/ijmecs.2015.01.04

[Dominic2, 2015] Maria Dominic, Sagayaraj Francis: An Adaptable E-Learning Architecture Based on Learners' Profiling, International Journal of Modern Education and Computer Science (IJMECS). — 2015. — Vol.7 — No. 3, pp.26–31; DOI: 10.5815/ijmecs.2015.03.04

[Dushyanthi, 2016] Dushyanthi U. Vidanagama: Acceptance of E-Learning among Undergraduates of Computing Degrees in Sri Lanka, International Journal of Modern Education and Computer Science (IJMECS). — 2016. — Vol.8 — No.4, pp.25–32,; DOI: 10.5815/ijmecs.2016.04.04

[Eljinini, 2012] Mohammad Ali H. Eljinini, Salwa Alsamarai,Suha Hameed, Amaal Amawi: The Impact of E-assessments System on the Success of the

Implementation Process, International Journal of Modern Education and Computer Science (IJMECS). — 2012. — Vol. 4 — No.11, pp.76–84; DOI: 10.5815/ijmecs.2012.11.08

[Guangran, 2011] Guangran Liu, Bencai Gao, Jun Lou: A Design of Learning Management System for Electronic Secretary Based on Ubiquitous Learning, International Journal of Modern Education and Computer Science (IJMECS). — 2011. — Vol. 3 — No. 1, pp. 9 – 15; DOI: 10.5815/ijmecs.2011.01.02

[Hilali, 2015] Z.S.H.Al-Hilali: Programmed, distant, mobile learning… what's next? "Bulletin of Taras Shevchenko National University of Kyiv; Series Physics & Mathematics". — 2015. — No. 4, pp. 75--81

[Hilali, 2016] Z.S.H.Al-Hilali V.P.Shevchenko: The structure of e-Learning system for the discrete mathematics. In Proc.: "Theoretical and Applied Aspects in Program System Development (TAAPSD'2016)". — 2016. — Kyiv. – pp. 252--256

[Inayat, 2013] Irum Inayat, Rooh ul Amin, Zubaria Inayat, Khan Badshah: A Collaborative Framework for Web based Vocational Education and Training (VET); Findings from a Case Study, International Journal of Modern Education and Computer Science (IJMECS). – 2013 – Vol.5, No.12, pp.54--60; DOI: 10.5815/ijmecs.2013.12.08

[Kocaleva, 2015] Mirjana Kocaleva, Igor Stojanovic, Zoran Zdravev: Model of e-Learning Acceptance and Use for Teaching Staff in Higher Education Institutions, International Journal of Modern Education and Computer Science (IJMECS). – 2015. – Vol. 7 – No.4 – pp. 23--31; DOI: 10.5815/ijmecs.2015.04.03

[Lytvynenko, 2015] T.I. Lytvynenko, T.V. Panchenko, V.D. Redko: Sales Forecasting using Data Mining Methods, "Bulletin of Taras Shevchenko National University of Kyiv; Series Physics & Mathematics".– 2015 – No. 4, pp.148--155

[Marikar, 2016] Faiz MMT Marikar, Neranjaka Jayarathne: Effectiveness of MOODLE in Education System in Sri Lankan University, International Journal of Modern Education and Computer Science (IJMECS). – 2016. – Vol.8 – No.2, pp.54--58; DOI: 10.5815/ijmecs.2016.02.07

[Maysam, 2012] Maysam Hedayati, Seyed Hossein Kamali, Reza Shakerian: Comparison and Evaluation of Intelligence Methods for Distance Education Platform, International Journal of Modern Education and Computer Science (IJMECS). – 2012. – Vol.4 – No.4, pp.21--27; DOI: 10.5815/ijmecs.2012.04.03

[Muhsen, 2013] Zahraa F. Muhsen, Adi Maaita, Ashraf Odah, Ayman Nsour: Moodle and e-learning Tools, International Journal of Modern Education and Computer Science (IJMECS). – 2013. – Vol. 5 – No.6, pp.1--8; DOI: 10.5815/ijmecs.2013.06.01

[Nagar, 2018] Rohit Nagar, Deepak K. Gupta, Raj M. Singh: Time Effective Workflow Scheduling using Genetic Algorithm in Cloud Computing, “International Journal of Information Technology and Computer Science (IJITCS)”. – 2018 – Vol. 10 – No. 1, pp. 68–75; DOI: 10.5815/ijitcs.2018.01.08

[Nawaz, 2012] Allah Nawaz, Muhammad Zubair Khan: Issues of Technical Support for e-Learning Systems in Higher Education Institutions, International Journal of Modern Education and Computer Science (IJMECS). – 2012. — Vol. 4 — No .2, pp. 38 - 44; DOI: 10.5815/ijmecs.2012.02.06

[Okey, 2019] Ambokile Okey, Anael E. Sam: Web-based Application Tool for Recommendation of Open Source Software for Higher Learning Institution in Tanzania, International Journal of Modern Education and Computer Science (IJMECS). — 2019. — Vol. 11– No. 2, pp. 33–41; DOI: 10.5815/ijmecs.2019.02.05

[Panchenko, 2003] I. Panchenko: An Alternative to the Erlang C Formula, “Corporate Systems”, (Kyiv) – 2003. – No.2, pp. 57– 59

[Panchenko2, 2003] I. Panchenko: Computer Modelling of the Mass Service Task, In Proc. Int. Conference “Informational research, applications and the study”, Varna, – 2003. – FOI-COMERC, pp. 55–61

[Panchenko, 2004] I. Panchenko, T. Panchenko: Call-Center Operation Optimization using Scheduling ISS v.1 Computer System, In Proc. Int. Conf. “Theoretical and Applied Aspects in Program System Development (TAAPSD’2004)”, – 2004. – pp. 272-274

[Pishva, 2013] Pishva Davar: Adoption of Innovative Education Strategies to the Needs of the Time: A Case Study of Ritsumeikan Asia Pacific University (APU), International Journal of Modern Education and Computer Science (IJMECS). – 2013. – Vol.5 – No.1, pp.1–13; DOI: 10.5815/ijmecs.2013.01.01

[Robles, 2017] Ava Clare Marie O. Robles: Evaluating the use of Toondoo for Collaborative E-Learning of Selected Pre-Service Teachers, International Journal of Modern Education and Computer Science (IJMECS). – 2017. – Vol .9 – No.11, pp. 25–32; DOI: 10.5815/ijmecs.2017.11.03

[Shariat, 2014] Zeinab Shariat, Seyyed Mohsen Hashemi, Asad Mohammadi: Research and Compare Standards of E-Learning Management System: A Survey, International Journal of Information Technology and Computer Science (IJITCS). –2014. – Vol. 6 – No. 2, pp.52–57; DOI: 10.5815/ijitcs.2014.02.07

[Shili, 2017] Shili Mohamed, Moez Chebbi, Santosh Kumar Behera: AMMAS: Ambient Mobile Multi-Agents System: Simulation of the M-Learning, International Journal of Modern Education and Computer Science (IJMECS). – 2017. – Vol .9 – No.1, pp.36–42; DOI: 10.5815/ijmecs.2017.01.04

Authors' Information

Zainab Saadi Hussein Al-Hilali *– PhD student at the Faculty of Computer Science and Cybernetics, Taras Shevchenko National University of Kyiv, 64/13, Volodymyrska Street, Kyiv, Ukraine, 01601*

e-mail: sufyanvpsh@gmail.com

Major Fields of Scientific Research: e-Learning, m-Learning, Distant Learning

Volodymyr Shevchenko *– PhD, Associate Professor at the Information Systems Department, Faculty of Computer Science and Cybernetics, Taras Shevchenko National University of Kyiv, 64/13, Volodymyrska Street, Kyiv, Ukraine, 01601*

Major Fields of Scientific Research: e-Learning, m-Learning, Distant Learning, Discrete Mathematics, Theory of Graphs

SAMPLE TEST BED AND EVALUATION TIPS FOR INFORMATION DEFINITIONS AND THEORIES

Krassimir Markov, Krassimira Ivanova

Abstract*: A sample test bed and tips for a corresponded evaluation for the new as well as for existing information theories and/or definitions are outlined in this paper. The sample test bed may be used as a platform for testing and comparing the information theories and definitions.*

Keywords*: Information Theories Evaluation, Foundation of Information Science, FIS.*

ITHEA Keywords*: A.1 Introductory and Survey.*

Introduction

During the years, the growing number of definitions as well as the scientific and practical research has shown the need of comparison of the theoretical results and, especially, the raised definitions and theories that concern concept “information” and its consequences.

This paper is aimed to make a little step toward evaluating the information definitions and theories. It is a result of fruitful collaboration between leading scientists united by an informal endeavor promoted by Michael Conrad and Pedro C. Marijuán in early 90’s, called the FIS initiative (Foundations of Information Science). It has been an attempt to rescue the information concept out from its classical controversies and use it as a central scientific tool, so as to serve as a basis for a new, fundamental disciplinary development – Information Science [Marijuán, 2020]. The FIS discussion list has been and still is an essential instrument to keep alive the Foundations of Information Science initiative [FIS List, 2020].

Let remember that at the FIS, rather than the discussion of a single particularized concept, information becomes the intellectual adventure of developing a "vertical" or "trans-disciplinary" science connecting the different threads and scales of informational processes, which demands both a unifying and a multi-perspective approach. Above all, the solution of the numerous conundrums and conceptual puzzles around information becomes the patient task of a community of scholars, in which the ideas and speculations of each individual thinker can be shared and experienced upon by the other colleagues, so that a sort of "group mind" develops (paraphrasing L. Hyde, 1979): one that is capable of cognitive tasks beyond the power of any single person [Marijuán, 2020].

To evaluate any information theory or definition we need more less common platform to receive compatible results. Such sample platform, usually called "test bed" is outlined below. A "test bed" is a platform for conducting rigorous, transparent, and replicable testing of scientific theories, hence including computational tools, and new technologies [Test Beds, 2019].

In the next chapter, the sample test bed is presented. The chapter after the next outlines some tips for providing good evaluating. Paper is finalized by concluding remarks and bibliography.

Sample Test Bed

For a sample test bed we have chosen a part of a letter of Gottlob Frege written to Philip Jourdain in 1914. Frege had written [Frege, 1997]:

> "Without a sense, we would have no thought, and hence also nothing that we could recognize as true.
>
> Let us suppose an explorer travelling in an unexplored country sees a high snow-capped mountain on the northern horizon.

By making inquiries among the natives he learns that its name is 'Aphla'.

By sighting it from different points he determines its position as exactly as possible, enters it in a map, and writes in his diary: 'Aphla is at least 5000 meters high'.

Another explorer sees a snow-capped mountain on the southern horizon and learns that it is called Ateb. He enters it in his map under this name.

Later comparison shows that both explorers saw the same mountain.

Now the content of the proposition 'Ateb is Aphla' is far from being a mere consequence of the principle of identity, but contains a valuable piece of geographical knowledge. What is stated in the proposition 'Ateb is Aphla' is certainly not the same thing as the content of the proposition 'Ateb is Ateb'.

Now if what corresponded to the name 'Aphla' as part of the thought was the reference of the name and hence the mountain itself, then this would be the same in both thoughts.

The thought expressed in the proposition 'Ateb is Aphla' would have to coincide with the one in 'Ateb is Ateb', which is far from being the case.

What corresponds to the name 'Ateb' as part of the thought must therefore be different from what corresponds to the name 'Aphla' as part of the thought.

This cannot therefore be the reference which is the same for both names, but must be something which is different in the two cases, and I say accordingly that the sense of the name 'Ateb' is different from the sense of the name 'Aphla'.

Accordingly, the sense of the proposition 'Ateb is at least 5000 meters high' is also different from the sense of the proposition 'Aphla is at least 5000 meters high'. Someone who takes the latter to be true need not therefore take the former to be true. An object can be determined in different ways, and every one of these ways of determining it can give rise to a special name, and these different names then have different senses; for it is not self-evident that it is the same object which is being determined in different ways.

We find this in astronomy in the case of planetoids and comets. Now if the sense of a name was something subjective, then the sense of the proposition in which the name occurs, and hence the thought, would also be something subjective, and the thought one man connects with this proposition would be different from the thought another man connects with it; a common store of thoughts, a common science would be impossible.

It would be impossible for something one man said to contradict what another man said, because the two would not express the same thought at all, but each his owns.

For these reasons I believe that the sense of a name is not something subjective (crossed out: in one's mental life), that it does not therefore belong to psychology, and that it is indispensable" [Frege, 1997].

In this example:

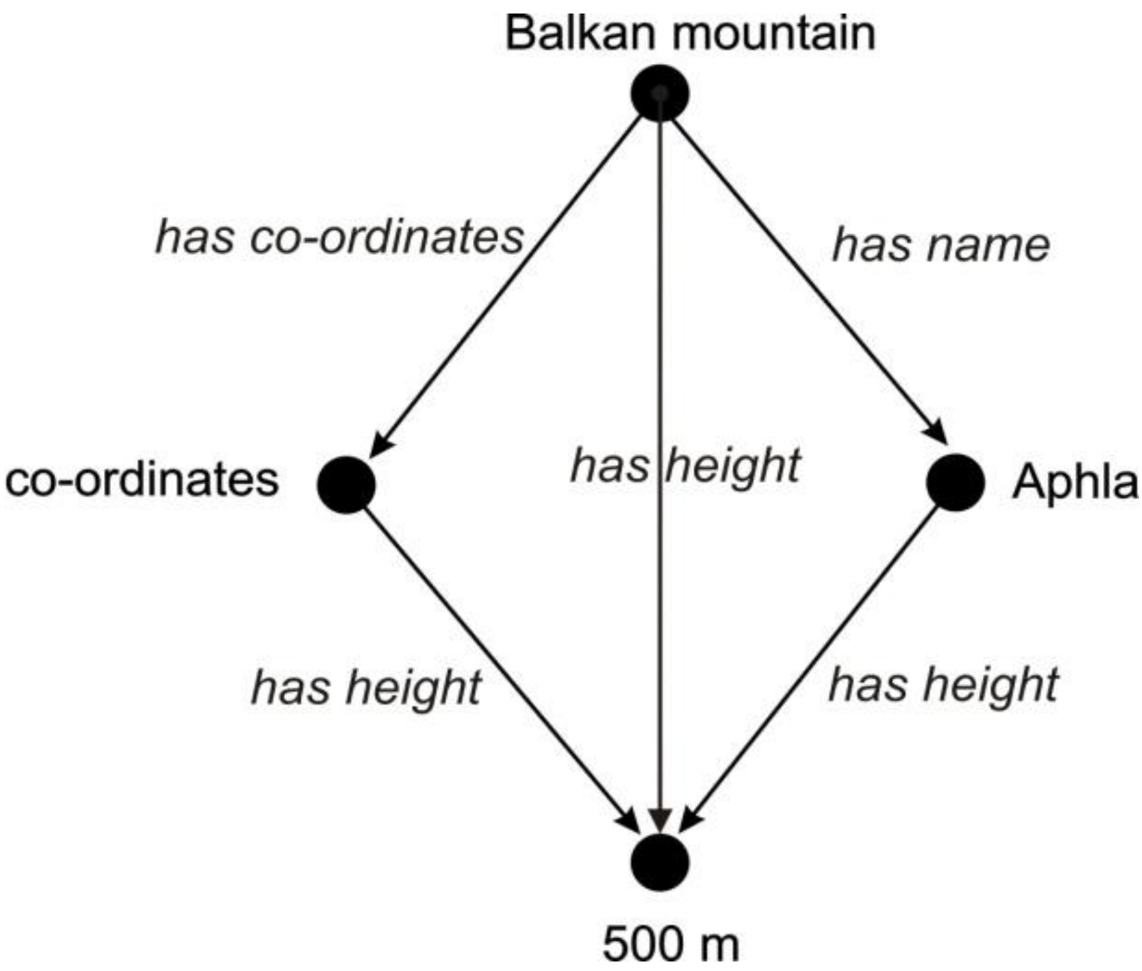
- The names Ateb and Aphla refer different parts of the same natural object (a mountain, let call it "Balkan");
- The position of the referred object (mountain) is fixed by any artificial system (geographical co-ordinates) which is another name of the same object;
- The names and the co-ordinates correspond one to another and both to the real object but without the explorer's thought represented in a map, respectively – in the explorer's diary, it is impossible to restore the correspondence;
-

- At the end, the names Ateb and Aphla are connected hierarchically to the name Balkan and the relations are:
    - Aphla is_a_South_Side_of Balkan;
    - Ateb is_a_North_Side_of Balkan.

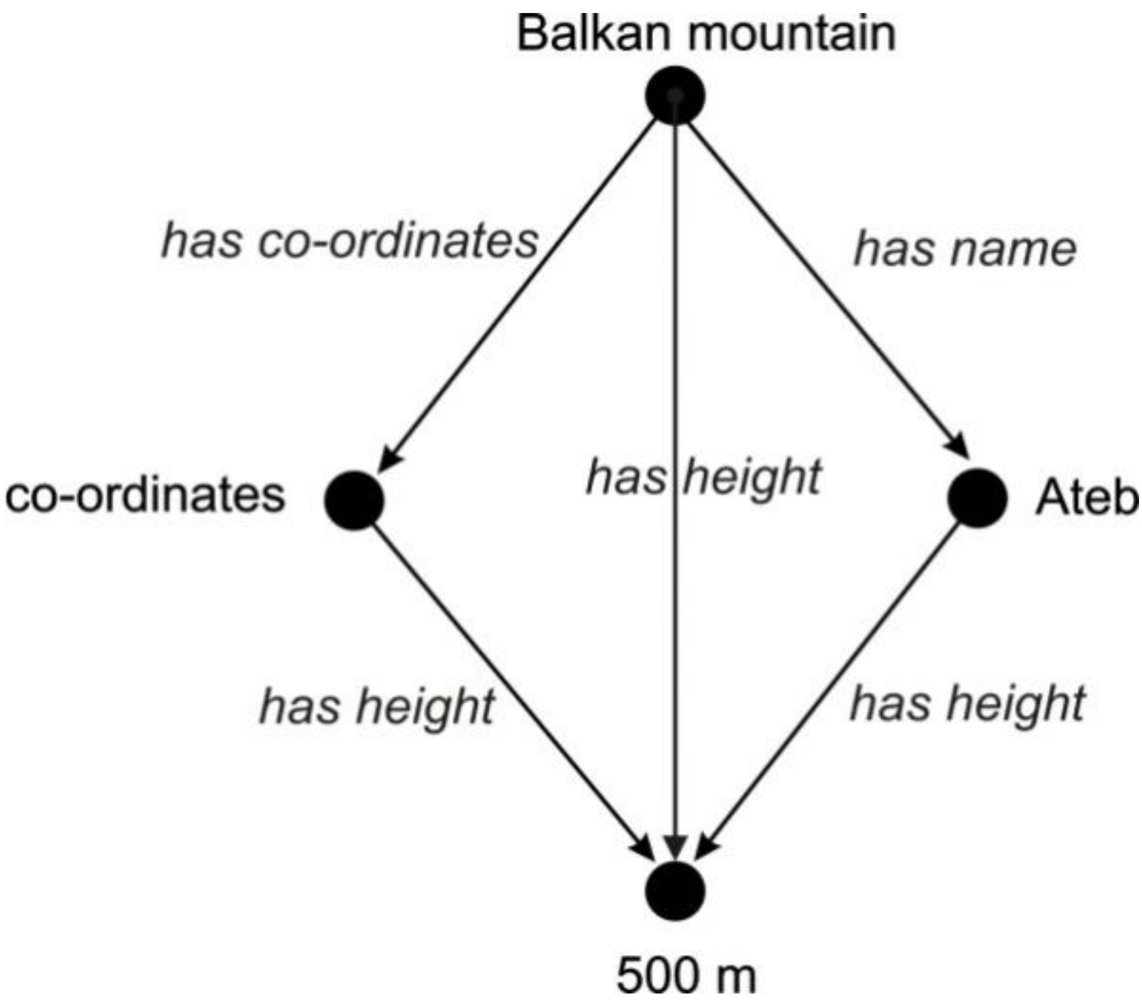
The last case forms a simple vocabulary:

name	*definition*
Aphla	The South Side of Balkan mountain
Ateb	The North Side of Balkan mountain
Balkan	A mountain in the unexplored country with co-ordinates (x,y)

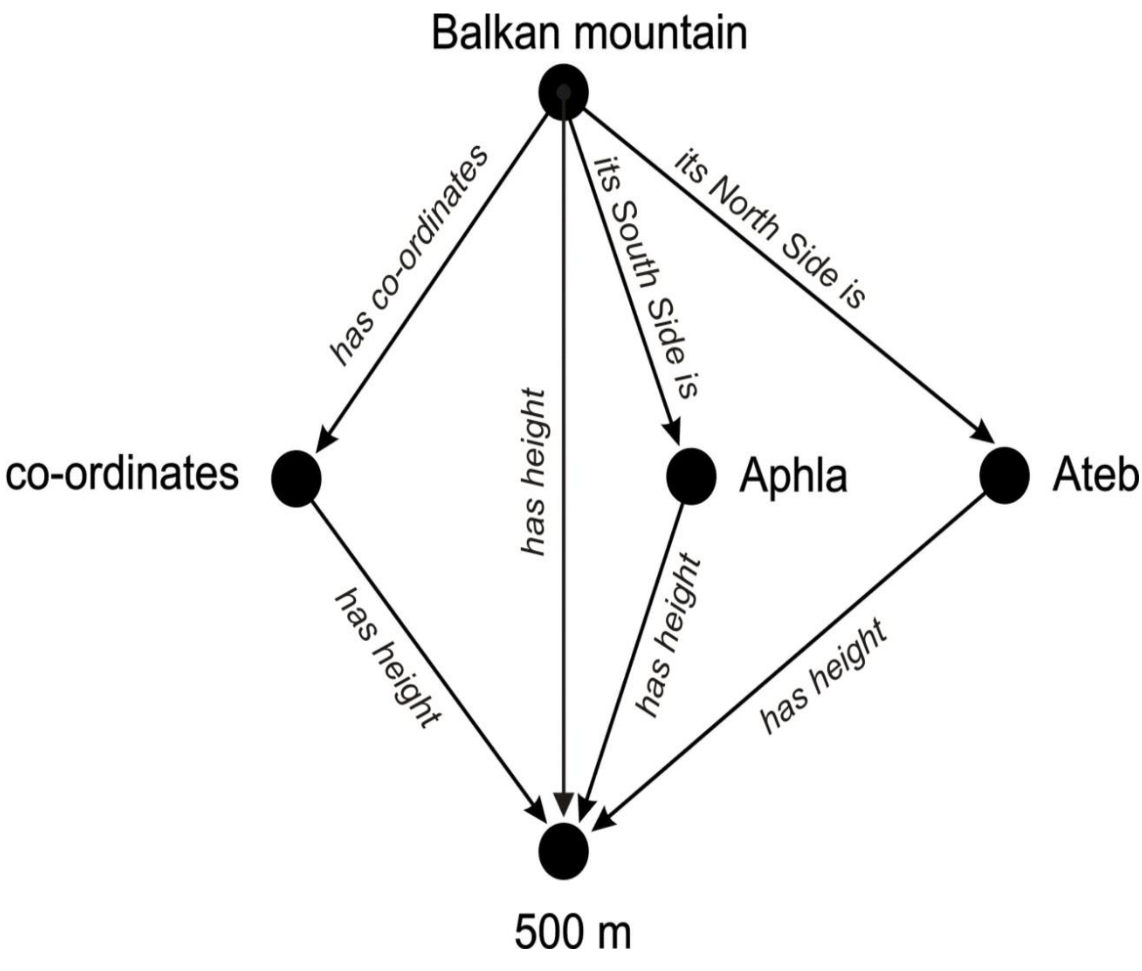
Let the interconnected thoughts of the first explorer may be represented by the following diagram:



Let the interconnected thoughts of the second explorer may be represented by the following diagram:



Finally, let the interconnected thoughts of the of the first and second explorers after their communication may be represented by the following diagram:



Evaluation Tips

The main goal of evaluation is to show main features of the definitions and theories. Because of this, it should be very short and clear without many details to make result incompatible. As a first step it may be answering the following questions:

1) Does the concept “information” is primary or “secondary”? If it is primary than easy understandable examples have to be presented. In the second case, if it is secondary concept, the primary concepts used for its defining have to be as little as possible, not the natural language at all.

2) Is it possible to give clear answer of the question what is the “information”?

3) If different types or categories of given term, for instance “information”, are defined, what they have in common to call them by the same name, though with additional adjectives?

4) Applying the definition and/or theory to the test bed it is recommended to:

- Clearly explain the difference between “Information” and “Data”.
- Clearly explain if for the proposed new term “information” and connected to it terms there exist already established terms, why it is needed to call with the new term already termed?
- Clearly explain and analyze the causal connections in the test bed.

Conclusion

The goal of this paper was to make a step toward understanding differences and similarities between information definitions as well as information theories. A sample test bed and tips for a corresponded evaluation for the new as well as for existing information theories and/or definitions were outlined in this paper. The sample test bed may be used as a platform for testing and comparing the information theories and definitions.

Further work has to be concerned to creative discussions and refining the proposed ideas.

Bibliography

[FIS List, 2020] http://listas.unizar.es/cgi-bin/mailman/listinfo/fis

[Frege, 1997] Frege, G. 1997. "Letter to Philip Jourdain, Jan. 1914."In The Frege Readre, Ed. by M. Beaney, Oxford: Blackwell. pp. 319-322.

[Marijuán, 2020] Pedro C. Marijuán. About FIS. http://fis.sciforum.net/about-fis/

[Test Beds, 2019] Learning About Test Beds. QA Platforms, 2019. https://qa-platforms.com/learning-about-test-beds/ (accessed 10.03.2020)

Authors' Information

Krassimir Markov, Prof. Dr. *– Director of the ITHEA Institute of Information Theories and Applications; P.O. Box: 775, Sofia-1090, Bulgaria; e-mail: markov@ithea.org*

Major Fields of Scientific Research*: General theoretical information research, Multi-dimensional information systems*

Krassimira Ivanova *– Assoc. prof. Dr.; University of Telecommunications and Posts, Sofia, Bulgaria;*

e-mail: krasy78@mail.bg;

Major Fields of Scientific Research: *Software Engineering, Business Informatics, Data Mining, Multi-dimensional multi-layer data structures in self-structured systems, General Information Theory*

FORMAL SEMANTIC INTEROPERABILITY – PRINCIPLES AND CONSEQUENCES

Venco Bojilov

Abstract

The creation of a modern formal semantic information theory as the basic framework of a very wide range of activities of actual civilization opens a significant area for research and development in modern science. A key direction concerning semantic information in today's constructive science is the task of correct transcription/translation of a substance encoded in different language systems, possessed by different "actors" in the conditions of collective existence and a huge variety of interactions within each super-system. In some other cases the huge amount of varieties becomes a brake in front of imposible implementation. The creation of a formal system of depicting a semantic essence/meaning in the world of various/diverse linguistic systems opens the way for the next civilization phase - the development of the Artificial Intelligence and its effective interaction with representatives/actors of the Natural Intelligence. The present work gives a framework for formal semantic compatibility and the subsequent semantic interoperability of different language systems describing real behaviour. A "canonical" form of semantic compatibility, conditions for partial or complete semantic interactivity is proposed, on the basis of which modern "failures" of a semantic construction could be prevented. Rules for accelerated knowledge definition and evolution in development of AI are proposed, as well as possible rationalization of the inherited natural intelligency book-entry of individual national civilizations could be performed either. The modern globalization of the civilization on the Earth opens up the problem of effective semantic interoperability as a key to the *coexistence of different civilizations with diverce structure - either sometimes in detai, or sometimes in deficiencies of highway technological knowledge. And the solution of such globalization is on top of the correct semantic interoperability implementation*

Keywords: Semantic Information Theory, General System Theory, Formal Interoperability, Semantic Communication, Semantic Interoperability

ACM Classification Keywords: H.1.1 Systems and Information Theory, Interoperability

##00 Introduction (Where the task derives from)

For a second decade human civilization is assumed to be already “in the age of knowledge and artificial technology.” But this is rather an intuitive or dismissive definition of a complicated and complex phenomenon in the actual development of civilization. It requires a number of meaningful additions to fit into the formally structured and scientifically approved schema definition.

In order to step out of the medieval scholastics’ tradition of "the number of devils lying down, seating ot standing up on top of a sewing needle," and the endless centuries-old controversy of church and biblical authorities on the subject, nowadays (in the information- and infrastructure-based civil society of the 21-st century), we have to leave behind some scholastic approaches for contemporary interpretation of Information, and in particular the common interpretation of the concept of Semantic Information (such as the conditionally formalized paradigm of Semantic Information as of Floridi [Floridi2003] with its purely quality-based "well-defined, truthfull and meaningful" semantic elements). Unlike the information in the communication process (Claud Shannon's time and the introduced formal entropy metrics), this scholastic semantics (by Floridi) does not have a very important characteristic - a MEASUREMENT by which to compare two semantic (non-zero meaning) descriptions of some phenomenon or object, made by two different Subjects regarding the same external to them Object/Event, and to evaluate their actual substitutability. Precisely this substitutability between different subjects-observers represents the sought interoperability for semantic information.

The problem with the framework and the measurability of semantics has been identified at the dawn of the Information Theory of the 20th Century by Weaver [Shannon1949] (i.e. in the "quantitative" information paradigm), namely the uncertainty of the semantic significance of the signal at the source in comparison to the signal’s content received by the observer, but somehow remains out of the focus of scientific interest until now, instead of receiving mathematical formalization in a natural manner and becoming a "natural-mathematical" science. The reason is the development of relatively simple artificial systems for processing information in the context of its artificial transmission/transport, rather than artificial (without the involvement of the Observer's intellect) interpretation. That is why semantics remains the subject of "humanitarian" and in most cases impotent treatment. But this "permissive ignorance" is very quickly running out.

The problem with semantic interoperability of accumulated and artificially recorded enormous amount of information expands with terrible force, as we enter the civilization phase called “post-industrial”, and even there appears a need for a "political" solution of the problem. Decision 922 of European Commission in 2009 [Dec 922/2009/EC], while structuring the general framework of the task of interoperability (in global civilizations and social systems) of the information used (in the various types of communication most often in writing) in a 5-level hierarchical model (Figure 1), practically fails to go beyond the "humanitarian" frame of Floridi’s one, and respectively the definition of a pragmatic, usable semantics fails to leave the scholastic range and to obtain a well-structured formal second "semantic" layer of the pyramid. Therefore, real interoperability remains at the misty and foggy intuitive level, and the construct obtained resembles a copy of the 25-century example of the Colossus of Rhodos and its clay legs, but in a modern, political context of the evolution of the European Union.

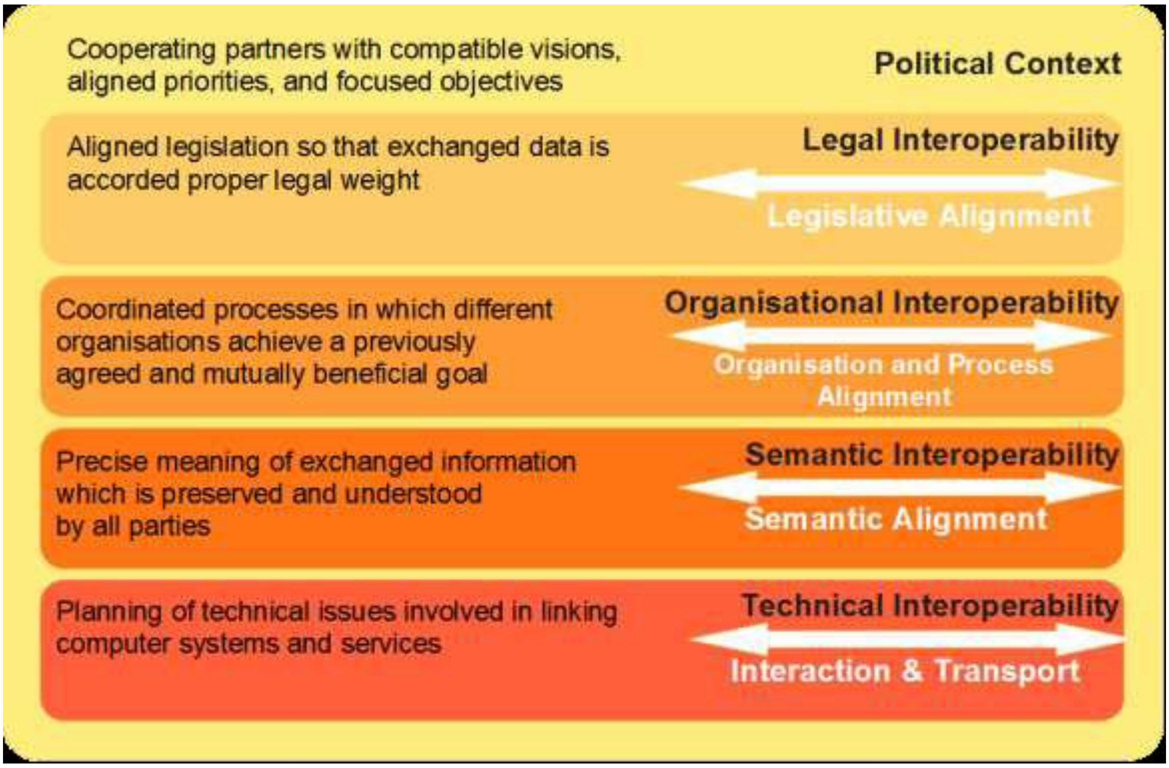


Figure 1. The 5-level hierarchical model of EU Decision 922 of European Commission [Dec 922/2009/EC]

Thus, despite the efforts invested and the relatively expensive program for implementing such interoperability in the successful implementation of the above three layers of architecture - organizational, legal and political - in the pyramid of the EU social administration by the end of 2015, capacity is untapped and unusable by the lack of foundation (!) - a formal structure of semantic information, which cannot be replaced by the various qualitative or, at best, low-quantitative metrics and concepts of semantic information and operations with it.

As an illustration of the de facto failure of a concept of semantic interoperability in the very complex environment of more than 28 national (natural!) languages with their own semantics, linked to the unequal level of development of material-technological processes in the individual (national) civilizations of the components of the EU system, we can recognize how the final program for flood risk prevention under Directive 2007/60/EC (in particular Article 6, par. 4, 5), where the common methodology for establishing a program for assessment, prevention and protection against floods [FludReport2011] includes the fuzzy (practically - collectively meaningful) , non-measurable on any scale (of semantic meaning) term "adverse impact on humans" associated with the simple parameter of {number of affected} in some way people. And this collectively meaningful, but fuzzy semantic sense (in a formalized administrative act) is attached /locked to something specific and structured on several levels of detail/ to the relatively complete and clearly measurable semantics of the hydrology sector (i.e, water catchment area, riverbeds with depth of flooding, water flow rate, float duration, etc.). - e.g. according to Regulation 1089, annex 2, p.8 [Reg1089/2010/EC] - over 65 entities, structures and concepts with reference to at least twice as many (over 100) key code values. How exactly an “unfavorable impact on humans” will be associated with each of the concepts, e.g. the “width” under 8.5.1.24 or the “geometry” under 8.5.1.13 (which, in particular, must in some cases represent the same meaningful sub-essence or component of the hierarchy-structure of the Hydrological Sector) here we cannot fix in a way other than that of the scholastic clerical fathers, counting the devils on the needle by ... reading the Bible. Such unequal structure of interaction between the general (concept) meaning and meaning of information components (in the relevant administrative regulation) according to mathematical rules is limited by the semantically the "weakest" components (similar to the least common denominator in math), those with the fuzziest structure and respectively, with the weakest and most minimalist semantic structure, which contains and gives the least amount of valuable information.

This dilution destroys the possible practical and effective construction of the connection (between cause and effect) of meaning, namely (in this case) – the listing of common EU structures and rules for a step-by-step and economically profitable investment towards concrete results (protective infrastructure, prophylaxis, increased sustainability, etc.) aiming at the final reduction of the number of people exposed to any (measurable !!!) adverse effects in the particular way. Further, as a result of an intuitively felt weakness regarding the recommendation under the Directive 2007/60/EC in the third part – that for a preparation of a general flood protection/ flood prevention plan - each Member State has received (from the Water Directors' Board) the full freedom to prepare its own (proactive defensive) policy at its own individual discretion (i.e., as each country individually understands it according to its own semantic hierarchy, when there is one) and with almost absent general (!) basis, hence virtually no interoperability regardless of the framework obligation under Decision 922/2009/EC. For this reason, despite the good overall structuring of the hydrological component (later elaborated according to Directive 02/2007/EU INSPIRE, [Reg1089/2010/EC] and the system for collection of hydrological on-site data, in the EU could not be generated a sufficiently effective system first to classify adverse impacts on humans and then to make mandatory cost-effective preventative measures against floods for all Member States.

##0. Background

The problem with the so-called "semantic" interoperability has long been recognized in scientific circles, but for a number of reasons and occasions this interest remains confined rather in the qualitative, philosophical (and more "humanitarian") scope of inquiries and paradigms, than in the quantitative/ engineering/ application scope. A good illustration of such semantic interoperability (in its philosophical) context of the definition in [Floridi2003] for semantics is the structured approach [Euzenat2001] for axiomatic and qualitive grounding of the consequence preservation between two entities and a structural sequential ordering between subject and object in the context of the rendering/reflection of the meaning (of the object as the subject is observing it). This structural order and "continuity" is well suited to the philosophical scope of the structural paradigms covered and described in [Masolo2010] and their fundamental interrelations (e.g. through first-order logic relationship), but somehow stands outside the measurable/ enumerable paradigms, and as such, falls within the scope of Gödel's incompleteness [Gödel1931]. In particular, the development of a system of semantic measurability and, hence, a principle of controlled/ measurable interoperability based on first-order logical relations (as of [Euzenat2001]) currently has measurability only in the context of Boolean logic, and only in its binary {1.0} paradigm, which coresponds unreservedly to the Gödel’s limitation, and this leads to too lean, drastically limited, elementary semantic dependence on binary arithmetic (e.g. the pair “yes-no” only) as the basis of semantic interoperability, without any Gödel's addition for correctness. Even the choice of characterization in the term "fixed consecutive preservation" (from [Euzenat2001]) as a collective noun/essence suggests, on the one hand, the "fuzzy" character of such a semantic relationship and, on the other hand, the minimal (at the level of uselessness) formal measurability of the phenomenon.

A similar disadvantage is present in any version of the so-called "ontological" paradigm for analysis of the process of semantic interaction, where in practice the main "ontology" as an enumerated set of entities is a form of Gödel's addition. Such ontology in the process of semantic-meaningful communication does not have the purpose of complementing towards full knowledge. According to [McCarthy&Hayes1969], ontology provides only the "alphabet" of communication specific to a defined cognitive field, not its own knowledge/complete_information_content (in comprehensive detail amount) which ideally permits/ coresponds to the complexity of any arbitrary (in the amount of detail) problem in the same thematic field. Here, under Knowledge, we include the entire volume of semantically meaningful information details in a certain subject/ thematic_field, not just the collective name of this subject/ thematic_field. Thus, any (ontological) alphabet can be used with a different application by the individual subject/ observer, when and only when we do not use any common integral knowledge as a binding/verifying component and as a basis in some semantically meaningful communication.

Later, [Gruber1993] defines ontology as an explicit (formal) specification of conceptualization, i.e. correct Gödel complement to the surrounding world (in some minimal volume) for every essence (from a certain level of complexity upwards). Previously, [Genesereth&Nilsson1987] have defined conceptualization as an abstract/ conditionally simplified image of the world (i.e., a SPECIFIC MINIMIZED amount of information) that complements (!) someone in their thesis – a description (of phenomenon, process or object) which ultimately can be depicted in a set of states and functional transitions of a structure (of some finite automaton or teleonomy). Such additional simplification, as an approach, limits the semantic-information power of the ontological paradigm, having application only in the simplest structural (i.e. elementary/ atomic) phenomena, and remaining powerless in the more complexly structured phenomena.

The framework of "ontology" always matches the qualification of Gödel's addition, but rather partly (i.e. within a minimal enumerable volume) than in full - to the infinity of the surrounding Universe. This means that the use of an ontological basis leads to the impossibility of a universal verifiable formal semantic metric, and as a result – the impossibility of absolute/ complete interoperability. The key weakness here is the limited sustainability of the semantic metrics in the process of constructing an "image" in a heterogeneous environment. This also leads to the necessity of a secondary (?!!) re-introduction of Gödel's addition (e.g. at the conceptualization level) which further weakens the strictness of any semantically consistent image projection between two different subjects. This in turn further requires an obligatory hard-weighted analysis of the impact of this (practically two-fold) conditional addition on the quality of such an image. And the impact of such double conditionality (of the correspondence between the images in two different subjects) further affects the practical collapse of the permissible degree of interoperability.

This semantic collapse of interoperability is also the basis of Theorem.4 (the Tower of Babel's) of [Bojilov2015], and is generally associated with a factorial (!) increase in the complexity of the task of comparison/ measurability of the structure of the Gödel's additions, both in a particular theory of inter-subjective communication, as well as in the semantic nuclei (within sets of compatible theories) of communicating non-"chiral" entities, which semantic nuclei (?) are limited-observable or not observable among themselves (according to Theorem.3 of [Bojilov2015]), and respectively are mutual blurry (from the standpoint of the entities) in terms of structure and content, and finally-substantially constrained or virtually unverifiable (in their entirety and fullness) from a practical point of view within a little more complicated (than the elementary Boolean algebra {1,0} paradigm of communication between such subjects. And the lack of such inter-verifiability of subjective theories (for the relevant semantically complete thematics' subject of pragmatic inter-communication) leads to the subsequent lack of an effective purposeful interaction between these subjects, degrading this interaction to a purely random (Brown's) movement-interaction or "white noise" of interpretation efforts.

Similar (albeit in the opposite direction) is the state of the modern popular semantic web paradigm of "self-increasing"/ growing (!) knowledge/ consciousness (as a hierarchically growing system of self-accumulated semantic information as of [BernesLee &all2001]). As they increase in parallel, almost infinite number of thematic directions, the respective ontological subsets from one moment on cease to be subject to synchronization between themselves. Hence, their (possible) potential semantic compatibility begins to lose its common roots and becomes subject only to the Gödel addition's acceptance with all its subjective limitations, but not to measurement and verification at least according to the volume of some partial general ontology.

Aside from the bulk expansion of the complexity of the semantics of such "semantic web"- type of information-gathering sets, there is also an additional obstacle to the interoperability processes. From a purely linguistic perspective (of natural languages and their uncontrolled increase of semantic amount by the respective population), arises an irreducible increase of synonyms and homonyms (where the same term in different context may have a different semantic content) and hence - a kind of anti-conceptualization in the sense of [Genesereth& Nilsson1987] at the integral system-level of Civilization Knowledge. This effect is further reinforced by the practice of (the relatively weak type of interrelation of) "consequence preservation" as a form of fuzzy, yet minimal semantic connectivity, in the absence of a measurement of this "consequence" and consequently of the strictness, the ranking or the enumerability (!) of the depicted relationships and structures. As a consequence of this effect, we come to the lack of even elementary rankings of significance of the various (often diametrically contradictory) possible "consequences" against the background of factorial complexity (i.e. unattainability, untractability) of the formal-complete verification of the compatibility between the available multitudes of theories.

Having in mind the limiting framework of Ontology and Conceptualization at the end of the 20th century, the semantic nature/ aspects of information are "overwhelmed/ buried" by Floridi's formalist scholastics within the scope of the "humanitarian" approach of semantic information development, which gives life and justifies today's semantic web "chaos”. Instead of detailization and growth of "non-entropy" and ordering in the semantic structure of the world, we are offered "noise whitening," an increasing number of "noise”-generating subjects, each one with his own private hyper-matrix for truthfulness, accuracy and relevance. And precisely in this chaos, maintained and expanded, including by the so-called "social networks" generating semantics and meanings noise, we were suddenly startled by … the "fake news" syndrome.

1.Concept framework

Building a formal semantics involves first specifying a framework for modeling the process, and then two key principles: a metric space and a direction/ vectoring principle. The pragmatic side (as principles) of the task of semantic interoperability/

compatibility can be sought in two main directions: in quantitative absolute and directional/ oriented metrics

- the first key point - a quantitative semantic metrics

For something to be measured, it needs to be (1)recognized, (2)classified and (3)made enumerable, otherwise we work with a binary metric (there is not, there are many - as an “addition”!), which metric is insufficient in power in the general, pragmatic case. In the paradigm of the interaction of two infinite sets (of entities that depict each other in mutial manner), we have only a PRIVATE solution in the context of Skolem's paradox [Skolem1922] when comparing only the measurable, enumerable parts of these sets. It is in this private case, that we can also define a metric that determines the boundary (!) of semantic compatibility of such two entities by means of enumerated sub-sets of elementary images owned by the respective subjects. The task would be easier if we succeed in expanding Skolem's paradox, not only by determining the enumerable parts of the sets A and B, but also by somehow fixing their Gödel additions or at least the enumerable parts of such additions within the scope of the part or the whole of their mutual interaction. In this sense, we can talk (and will comment below) on:

- **A full semantic metrics (1.A)**
- **Partial/ Local semantic metrics (1.B)**
- **Hierarchically structured semantic metrics (1.C)**

- the second key point - the directionality/ “vectorality” of semantic compatibility, respectively one-way or two-way of such compatibility - a property that has been very rarely explored.

The majority of works on semantic interoperability are limited to one-way/monodirectional analysis of the depiction/ display (in particular, for example, in [Euzenat2001]), where if entity A is evaluated as semantically compatible with entity

B, the opposite (B to A) is neither affirmed, nor analyzed. The problem of bi-directional retention of the essence (and the related consequence preservation) is not specifically addressed, and hence the vague practical (and very often fraudulent) application/ implementation of the inquired „interoperability" property to a semantic level of interaction of entities and/ or systems (operating with information) only recognize one-way imaging. As a result, only one-way (!!!) semantic compatibility is considered, when a meaning coded in a system of meanings (of a given nature/ entity) is depicted in some (but not exactly measured) degree by another similar system (of another nature/ entity), but not for a pair of industrially identical systems/ entities. Here the implicit default compatibility illustrates the possibility for ONLY a correct IMAGING of the subject A semantics through the subjective semantic system of B.

When talking about bidirectional semantic interactivity, the paradigm frame changes substantially, and we enter the [Hoare1978] paradigm for communicating sequential processes, in which one subject A having semantics SXa sends messages to another subject B with SXb semantics. Then, the direction of communication is reversed, and these two entities manage to implement a common policy of existence/ operation fC{□(SXa),□□(SXb), A,B} Here, however, the paradigm does not focus so much on the synchronization of the processes/ steps of the individual subjects A, B over time, but on the synchronous representation of SXa on SXb and vice versa - of SXb on SXa. In this sense, we can talk (and will comment below) on:

One-way semantic compatibility (often from larger volume semantics to smaller volume semantics) (2.A)

Two-way/ mutually semantic compatibility (2.B)

##2. Basic paradigm of semantic compatibility

The above-mentioned metrics and direction should be projected onto some basic paradigm on which to be observed the effect of semantic information and the pragmatic need for semantic communication. A paradigm framework for the task of semantic compatibility and interoperability can be taken from TSI [Bojilov2015] - lemma 5 for the conditions of semantic equivalence of two entities and the preceding definitions and assertions by focusing on the communication processes between (two) subjects in the context of pragmatic (secure) communication as of [Hoare1978]. This framework, however, corresponds to full structural equivalence of the interacting subjects, and should therefore be regarded as a particular case, namely as the upper boundary of formal semantic compatibility. At the same time, this framework requires in advance a preliminary somewhat wider, philosophical comment on its potential applicability.

For the purpose of determining a philosophical basis (of the world and the semantic information in it) as a structural space, we will apply the tripartite classification paradigm described in Chapter 11 of the UTI [Hoffkirchner2010] (compatible with the model of Appendix 2 from TSI [Bojilov2015]) where:

* "teleomatic" entities reflect the balance of fundamental natural forces and low-level laws (1-2) and the resulting (physical and chemical) structuring of matter in space.

** "teleonomic" entities reflect observed processes of local self-structuring with a clear start and span of the maximum structural finish (level 3) - simply referred to as the collective notion of (biological) "life" basis.

*** "teleological" entities possess in addition to their teleonomic structure, self-contained (independent) behavior, based on the reflection of the world (i.e. collection of semantically meaningful information from the environment) and its targeted use (4-5 level) that we can simply qualify as "animalia” and “civilizations".

Floridi's definition and description [Floridi2003] of semantics through “meaningful,” “well-formed" and “truthful” information/data implies normalizing the paradigm of "semantic information" in a sufficiently simplified and at the same time mathematically accessible model. The above enumerated qualitative philosophical pyramid will be projected/fit into the formal measurable (!!!) structured paradigm of the finite automata theory, well-developed since the mid-20th century.

Why use the paradigm of the FSA theory? In the above-mentioned paradigm as of [Hoare1978], we can detail the semantic interaction up to a formal model of the type (1:1) (i.e., the elementary language signal of Automaton A to be matched with the elementary language signal of Automaton B), while for the paradigm of "consequence preservation" (according to [Euzenat2001]), the minimum possible variant is of the type (1:M) (i.e. a single signal from Automaton /Entity A can be attached to the M signals from Automaton/Entity B), and in the general case – even (N:M) type. Anyone of these models (1:1, 1:M, N:M) is consistent with the popular complex (!) semantics structure paradigm of “entity-relationship” [Chen1976] where integral imaging of many atomic entities is constructed in upper level system entity

In the case of FSA, while in variant (1:1) we have a non-polynomial (NP) complexity of the Observer, i.e. a reachable in time and complexity solution, for the other case (N:M) we have a factorial (!!!) complexity, i.e. untenable in time and in technical complexity. This makes such an approach formally NOT APPLICABLE in a real practical situations and, both for the different policy initiatives for inter-language interoperability (in the EU), or for the simpler formalization of a normative basis of civilization (better known as "e-government" in the hierarchically and orthogonally expanded systems of modern administration) - are practically impossible and are to be accepted as propaganda manipulation only.

As a drill down on this framework, a solution to the task of form only alizing the semantic information (through several definitions and statements below) will be proposed in the context of the general theory of FSA (finite state Automata) (e.g., by [Arbib1969], [Kalman&All1969] or [Hopcroft&Ullman1979]).

The primary classification of finite automata determines:

* Finite state and endless state automata (as of [Scolem1922] - finite enumerated and endless countless/ (fuzzy or blurred)/ uncognizable(!) set - structural entity as a kind of entity).

** Deterministic and stochastic automata (respectively with a defined, observable and undefined, fuzzy (unobservable) structure, description, and respectively behavior).

*** Sustainable and unsustainable deterministic finite automata (since endless and stochastic automata can only be unsustainable on a fixed parameter and in an infinite time interval)

It should be explicitly noted here that a Finite State Automata can have both an elementary structure (e.g. a T-trigger) and a very complex and voluminous structure (a computer system with a loaded large database) that from a practical standpoint can play as an "infinite" machine compared to other finite ones with minimal structures.

The projection of the conceptual (philosophical) natural structural hierarchy over the formal paradigm of the FSA takes the form of:

* teleomatic structure - is a special/particular case of a finite automaton (FSA) with rather a single state - a balance of different physico-chemical forces.

** teleonomic structure - finite automaton with deterministic (DSA) or (in rare cases) stochastic structure and multiple internal sustainable states.

*** teleological structure - an infinite machine or a finite state stochastic automata with very large number of sustainable and unsustainable states

In the above "coordinate system" we can describe the task of semantic consistency/ interoperability in the paradigm of TSI [Bojilov2015] as follows:

2.0. For communication/ interaction between two entities (DSA with a minimal teleonomic structure) we can only speak when these two entities are isomorphic in some (even partial) degree. The trivial isomorphism of DSA with structural power of 1 (i.e. FSA with only one state!) which corresponds to teleomatic entities, does not generate an Observer' structure, respectively, does not produce an image, and is not subject to semantically significant communication - a downward, lowest boundary of the interoperability phenomena!

2.1. Each Subject (as a minimum teleonomic power of entity) is an Observer-owner of a locally limited (in the sense of Theorem.3 by [Bojilov2015]) semantic system, which in its turn can be regarded as (sub-structure □□of) deterministic state automata.

It can be agreed that in the Universe there are always several or many more different observers (besides the Observer of the subject), which require active interaction inside or outside the context of some super system.

2.2. Communication between Subjects having different semantic systems implies limited interaction of their individual semantic systems (also sub-structures of the DSA) in that part of theirs (!) which is isomorphic or K-equivalent (K>1) where the power of such interaction is limited by the "length of equivalence" - {<K! (factorial of K)}

2.3. The purpose of such communication (i.e. the pragmatics of semantic communication in the context of the TSI [Bojilov2015]) is the possibility of using the semantic context of one/first entity/subject in interpreting the observed/ controlled actions of another/second entity/subject.

Along with the base frame, we can also detail a number of specific sub-tasks. We can talk about two parts - Local and Global Semantic Compatibility (under Task 1.B). Local semantic compatibility we will consider as the conditions of private interactions between two entities with some pragmatic distinction in volume L in the context of the total K equivalence where L < K. Alternatively, Global semantic compatibility will be considered in context of K + G equivalence (G > 0), where G reflects the amount of functionality from Gödel's virtual addition to the semantic system of the corresponding physical entity-Observer (in the context of task 1.C).

We can distribute local and global semantic interoperability into several more specific non-formally named sub-directions, such as:

* A complete paradigm and a written Gödel addition - a description of the world (or "super-ontology" and the volume of the assessed addition) as a global but unachievable goal (because of complexity and volume) (task 1A).

** Groups of entities with Population Language ("localized globalization!"), subsystem/ administrative slang - component-differentiated specific location and principle of components interaction in the role of differential/ partial interoperability (task 1.B).

*** Inter-semantic common sets (most often related to the process of structuring and typifying relations in the "entity-relationship" model at different hierarchical levels of real complex physical structures - integral supersystems formed by the individual component "bricks" with non-minimal own structure (like teleonomic level ones) (task 1.C). There we observe the typifying of the relationship: level of logical sequence (task 2.A) and bi-directional {structure-meaning} transformation (task 2.B) but of the level of the matching component, rather than the level of integrated super-system. Such typifying is most often associated with the sub-functional teleomatic community components in teleonomic structures, or of teleonomic community components in teleological structures.

**** Thematic sets (through orthogonalization of meaning space: partial and local interoperability and operational meaningful interoperability) (task 1.B). As a form of orthogonalization, conceptualization can also be considered - minimization and simplification/ reduction of the paradigm of observable signals, states and transformation processes with respect to the dynamics of a certain sufficiently complex entity to some minimal complex state with preserved pragmatism, under which complexity such pragmatism disappears.

##3. Formalized Semantic’s metric.

Every distinct Entity in our material world (in accord with the three-tier hierarchy above) can be represented as a finite automaton of the type

fsM = {Q, □ ,□□□: Qx□Y□Q, q0, F} (1)

where

Q - the finite set of states,

□- the automaton input “alphabet” (here the “alphabet” contains any possible “external” signals - both signs and “words” composed of many signs, not the trivial type of alphabet characters in the CNF3 form).

□ - an array of transformation functions / processes (both of the system and subsystem / component’s level) which performs conversion from one stable inner state to another inner sustainable state under the influence of an external signal.

In the above presentation, we intentionnally drop out two more components - Output Alphabet Y of the Automaton and Output Function□□: Qx□YY , which do not directly participate in the semantic interpretation of the input signals

(The FSA mechanism, even in the time of its creation, has been used to describe complex structures, including modeling of living organisms, even by M. Arbib in the 60s of the last century.)

Def.D0. Such an Entity, which can be visualized with the paradigm of the finite automata through a simple linear FSA with one input, one output and a set of internal states (with minimal, non-collapsible structure) and has an image of the surrounding world by means of the specific closed set of signals-□□□ as incoming “alphabet”, we will call FLAT / One-dimensional Entity (with one-dimensional information-operational space through the single input)

Def.D1.The input information capacity of such an Entity corresponds to / depends on the power of the modeling FSA (quantity of communicated information) and is determined by the size of □□as a quantity of accepted / recognized and independently processed input signals -□:

inf(fsM) = |(□)| (2)

In terms of a finite automaton with p input signals, 1 outgoing output and n internal controllable states that have structural power of (n)np or {struct}p the power / volume of the information in it will be equal to the overall Entity in the logarithm at the base of the structure, or

|(□)| = log(struct) [fsM] (2A)

Def. D2. We will call "Theory" of the Entity (or language of Entity) □(fsM) L(□) the set/ multitude of all words or signals received by the Entity/ automaton, together with the special zero/empty signal ε where the Entity does not change its state and does not perform any transformation functions

Def. D3The semantic content of the received signals (their meaning or the pragmatic definition for formal Semantic information in a local Entity-finite automaton) is determined on the grounds of how they (the signals) are worked out inside the Entity as set of states transition:

Sinf(fsM)={ □ |=(Q, □} (3)

as an input word wi T□□corresponds to a transition from one state to another (qi -> qj) with implementation of a transformation function di T□

The above definition corresponds to the assumption in [Bojilov2015] of the principle of exclusive semantic locality in the respective information system of an Entity from the 4th and the higher hierarchical system level

Lemma.L1. TheTheory T (fsM) is meaningful (ie semantically complete) when and only when

* For each word / signal (except the zero one) wi there exists at least one valid possible executable transition (qi -> qj) of the state of the Automaton;

** For each word/ signal wi there is at least one transformation/ performance of function di, which is not zero /not empty.

*** For each transformation function d concerning transition from one qi state to another qj state there is at least one valid word/ signal wi able to activate such transformation

**** For each state q (except the terminal one F), there exists a valid word/ signal wi to output it by means of corresponding transformation function

For any other conditions except the set of the above ones the constructed Theory shall not be fully meaningful.

Another definition of the Lemma 1 for meaningfulness postulates that if the Entity/ Automaton fsM fully perceives/discerns the meaning of T (fsM), then respectively the image of the Entity /Automaton through T (fsM) is meaningful (Floridi’s first clause) and true (Floridi’s third clause)

Here the third clause of Lema1 requires additional comment. It is assumed that not for all states transition qi in qj exist a transformation function d. Otherwise (for completeness of transitions) clause 4 will require N-1 different output signals, in view of the transition to each one of the other remining N-1 states

Lemma.L2. The Theory T (fsM) is well formulated if and only if when

* For each word / signal (except the zero word) wi there is only one valid transition (qi -> qj) of the states of the Entity/Automaton;

** For each word / signal wi only one transformation is performed (i.e. only one di function is performed), which is not zero/ empty transformation.

*** For each transformation function of transition from one state to another there is only one valid word / activation signal

**** For each state (except for terminal one F), there is only one valid word/ signal outputing it by means of the corresponding transformation function

Another definition of the Lemma 2 on well formulation postulates that the Entity/ Automaton fsM perceives/discerns the meaning of T (fsM), then respectively the image of the Entity/ Automaton through T (fsM) is well formed (Floridi’s second clause!!!) and minimal, and the Theory T (fsM) corresponds to Chomski’s CNF3.

The fourth requirement is a key to transforming a well-formulated semantic system into a linear deterministic FSA, from this to a limited complexity of the system which is achievable for materialisation and real-time existence of limited in space and time Entities. Otherwise, for all N system states will be needed up to N! (factorial of number of states) input signals to respond to the lemma requirement for meaningful semantically-complete Theory. In the real world, functional completeness of structurally complex automata having multiple stable states and a complete number of transitions is generally not seen, having in mind the non-linearity of matter at teleomatic level. A complete number of transitions between states (along with the associated two-way/ reflexivity of internal processes in such a finite automaton) contradicts the defining characteristic of teleomatic entities and their internal processes. As a consequence, their hierarchical upgrading - teleological entities and structures - are also unable to build, and therefore manage/ communicate a complete number of transitions in their own organism and in the near vicinity, which can justify the existence of such communication-semantic power. In this sense, Lemma 1 for a semantic completeness is applicable only in the framework of the corresponding total number of transitions between states of a given Entity, and its third clause applies only to very simple (binary) structures, and in general - only for PART of transitions between states qi in qj, that are real in such a structure, and not for theoretically impossible set of complete count of the transitions between states of the FSA.

Having in mind the structural semantic definition of Theories of Entities and the possible pragmatic communication between them, in addition to the pure mutual communication (both pragmatic or arbitrary /senseless) the notion of “interoperability”could be introduced. Local semantic interoperability can only be considered in the context of at least two Entities/automata communicating with each other. Before interoperability’s property we assume substantial multy-words Theories and not trivial single-state internal structure for each entity

Lemma.L3.When we try (and succeed) with the set of the signals of the Theory T(fsM1) to manage the Entity fsM2 we call it local one-way interoperability of fsM2 from fsM1. When fsM2 accept completely the meaning of T(fsM1) (all elements of the theory), there is semantic interoperability of fsM2 from fsM1 (we will note with >=>)

Lemma.L4. When, apart from the one-way semantic interoperability of fsM2 from fsM1, we observe simultaneous fsM1 interoperability from fsM2, we are talking about local full bilateral/ bidirectional semantic interoperability of both Entities (we will note with <=>). Such a condition corresponds to the isomorphism of fsM2 to fsM1 when the two entities are viewed / accepted as finite automata in some form of communication with the world

Semantic and full bilateral interoperability in particular is equivalent to the notion of homomorphism at the functional level of the two respective entities (or spaces in a broader sense), the fsM1 image of fsM2 and vice versa being continuous in space and time

Theorem.T0: Global (complete) semantic interoperability of different structural entities does not exist and can not exist in the real world.

The proof of the above statement is easily derived from Theorem3 from [Bojilov2015] – to be able to have interoperability with all the structures of the Universe, we must also have Entity A with an information capacity exceeding or at least equal to the capacity of all other Bi, i.e. of the entropy of the Universe. However, such capacity also requires structural entropy of Kolmogorov in a volume equal to or greater than that of the Universe

We can talk about Semantic Normalization of Structures (by analogy with the conceptual normal forms of the Relational Databases). In the context of the conditions defined by Lemma1 and Lemma2, a semantically complete and semantically well-defined image of Entity created through the set of symbols / words in the "alphabet" □□can lead to resultant orthogonality of the components of the entity as a whole, so that one signal atom will have only one distinct state and one atomic functionality in the common/general frame of a FLAT semantic system. In addition, such orthogonality corresponds to the principles of a minimal structure and the non-minimizable automaton as formal properties of the FSA (i.e. we have equivalence between the minimal linear Automaton and the concept of well-formulated and meaningful semantic theories of Lemma2)

Def.D4. Semantic Length Concept - Until the number of input signals is involved in calculating the power of a structure of a FSA, then the quantity (number) of normalized independent/ non-repeating elements (w1, w2, ... wN) from language □□of theory □(fsM) (in normalized conditions as of Lemma1 and Lemma2) will denote the capacity of this semantic set (according to the capacity of the functional structure of the Entity) and may serve as a pre-enumerated form of isomorphic recognition of two entities, from there - their possible semantic compatibility. Such quantity/number of input elements can be named as “semantic length” of an entity.

Will be presented below definitions of formally unattainable/ countless or hard-to-manage images

Lemma.L5A. The Theory T (fsM) is a fuzzy set about the depicted structural Entity (ie semantically incomplete) when:

* There is a transformation function for transition from one state to another state, for which exists no valid word/ activation signal;

** There is a state (except terminal F one) for which no valid word/ signal for state output exists;

*** For each word/ signal (besides the zero/void one) wi there may exist more than one valid transition (qi -> qj) for the automaton ‘states (structural "homonymy");

**** For each word/ signal wi more than one transformation can be performed/it performs more than a single di function which is not zero/void one (functional "homonymy").

The above specification corresponds to the so-called stochastic automata (NFAs) whose some transitions from one state to another state are kept attached to a zero/ empty/ void signal/ word ε, and whose available description can be perceived as an incomplete description one.The Transformability Theorem of NFA set to a DFA set can be seen as way of ADDITIONAL study and description of a practically unknown Entity/ Automaton by adding semantics to achieve a level of well-formulated Theory of this entity. However, in the particular case of functional "homonymy" (in CNF0 languages), a real entity/ automaton (which corresponds to the definition of a finite state machine with starting and final states) can not be constructed in secure and binding manner, and thus to exist indefinitely in time and space such as "teleonomic" or senior type "teleological" structure

Lemma.L5B. The Theory T (fsM) is "blown"/"inflated" (ie semantically soiled/ overloaded) when:

* There is a word/ signal (except the zero/void one) wi perceived by the machine for which there is no valid transition (qi -> qj) of the state of the machine; or a transformation / performs a di function that is zero/ empty.

** For each transformation function di for transition from one state to another, there may be more than one valid activation word / signal (activation synonym)

*** For each state (except for terminal F one), there may be more than one valid word / output signal through the corresponding transformation function (activation synonymy)

The above specification corresponds to "multilingual" FSA, which in practice can be activated by a very wide range of external signals - under certain conditions to be controlled with "multilingual" activation, and under other specific conditions – to be activated to multilingual “suicidal” (!!!)reaction. For the multitude of FSA with bloated theory of communication with the outside world (which is an effective model of today's human civilization !) it is possible to speak about/interpret only partial "interoperability" (and partial manageability/ sustainability in such systems) in light of a particular case activation "synonymy" in simplest contextual-independent languages (at CNF2 level).

Def.D5. The concept of semantic definition versus semantic fuzzyness can be fixed in several directions:

* The white noise is completely semantically-blown/inflated

** The empty signal is semantically fuzzy

*** The Entity’s partial semantic definition corresponds to the semantic fuzziness of the Theory □(fsM) - when the list of the entity Interface of FSA □ has a length smaller than the semantic length of the structural functional meaning (Q x δ).

##4. Monodimention and Multydimention (in semantic space)

The above rules refer to relatively simple structures and their image corresponding to the def.D0 for one-dimensional entities. In fact, complex hierarchical systems can only be seen around:

* either as complex PARALLEL / Orthogonal (!!!) sets of individual elementary (flat / one-dimensional) finite automata that have (each elementary automaton separately) a separate own input for interpreting different signals (in a common multi-

entry system), or common input, but a different thread of interpretation / different semantics of each individual orthogonal process;

** or as complex hierarchical-component SEQUENTIAL systems, where the state / process in a component elementary fsMkj is an input / signal / word from the Theory of Next (Down and/or Upward in the Hierarchy) component - fsMki.

Then for the orthogonal multi-dimensional structures, we can apply a matrix form for defining semantic information of the type:

Sinf([fsMi])={[□i□ |=(Qi, □i]} i= 1-N} (4)

In terms of complicated hierarchical multi-component structures we can still talk about a vector of sensors and multi-entrancy interpretation, but this time in a common integral language of symbols and own set of states of the type:

Sinf(FM([fsMi]i=1,N; Qji(fsMi) j=1,M)={[□i□ |=(Qi, □i], □I W Qij i= 1-N,j=1,M } (5)

The introduction of a structure on the flat / one-dimensional Entities-Automata opens the possibility of treating in detail the case with the fuzzy and expanded semantics. Under certain boundary conditions every entity with either fuzzy or blown semantics can be transformed into a deterministic structure of elementary regular "flat" entities in the context of lemmas L1, L2. In that way a stable, complex FORMALISM of the hierarchy can be constructed, which will allow an adequate formal representation of the integral meaning. Hence an adequate multidimensional scheme can be elaborated for partial, and then (with certain conditions for interaction of the components) complete formal verifiable interoperability of hierarchical entities/ systems will be possible to be described by means of the conceptual formalism presented above.

The interrelation between two essences in the simplest case, one of which - with flat/ one-dimensional structure and theory □(fsMa), and the other with a two-plane structure and the theory T(fsMb2) = T(fsMb1, T(fsMb) can be subject to explore in view of unilateral and bilateral interoperability within the meaning of Lemma.3, Lemma.4. If we write the structure of the two entities we will see that the first flat one can be represented as:

□(fsMa), ->> {[□3a□ |=(Q3a, □3a]} (6A)

While the second one (the composite) can be represented as

□(fsMb) ->>{[□2b1□ |=(Q2b1, □2b1={D1b2,[□2b2□ |=(Q2b2, □2b2]})} (6Б)

And then we can get the following properties:

If □(fsMa) >=> □(fsMb) than (6B)

than □(fsMa) >K>□(fsMb1;

□(fsMa) >K>□(fsMb2;

Def.D6. Concept of semantic hierarchical rank - where an element/ component in a semantic set (i.e., .wi of the language Σ corresponding to the set {qi, [Dik]} where k - number of possible functional transitions to other states in the Entity/automaton) is presented as a conjuncture of two or more sub-elements of that same set (e.g. wi = wk U wk + 1) - we are talking about such a element of the next rank in such an entity / automaton.

The concept for hierarchical representation of semantics contradicts the definition of Lemma1, Lemma2 for well-formulated (orthogonal) semantics, especially when the input signals/ words wi, wk, wk + 1 exist originally in the set □□□Such a phenomenon refers to a "blown/inflated” semantics

Lemma.L6A. Formally meaningful and semantically correct theories can only be those theories that are itself/ are conductive to - zero hierarchical rank (i.e., flat/ one-dimensional structure) for the specific entity.

Lemma.L6B Any theory T (fsM) whose language □□is of a hierarchical rank higher / lower than zero, is formally considered to be "blown"/”inflated " in the sense of Lemma.5B, and as such has (compared to other theories) limited semantic interoperability, or requires special (Gödel) additions to achieve semantic interoperability with other entities / systems, including from a similar external level.

The proposed definition has an informal interpretation : it is analogous to the principle of methodological reductionism employed in description of entities, and formulated by the so called "razor of Okam"- the 7 centuries’ old practice, actually known from more than 23 centuries ago, from Aristotle's time.

Def.D7A. Concept of an evolutionary normal semantic hierarchy

In a given Entity/ automaton, when the transition qi -> qi + 1 performed by the functional transformation Di, upon receipt of input signal wi, is broken down into a set of new intermediate states and new intermediate functional sub-transformations, i.e. we will consider this single transition as a new component (!!!) finite machine with its own not-null structure and its own component theory T(fsMi), the union of the output theory T(fsM) with the component T(fsMi) will be called "normally expanded" or "normally increased" hierarchical semantic system.

The above definition corresponds to the natural evolution of knowledge,when in one moment a given entity (as a whole) begins to consider itself as a complex of components without disturbing the sustained interaction of that entity (as a whole) with surrounding similar ones within a certain super system. In particular, the super system can also be the Ontology of the World around us. Naturally, interaction with these individual components, not with the whole entity, is made at another (lower) rank of communication

Lemma.L7A The "normally expanded" hierarchical multi- rank/multi-layer semantic system is subject to "semantic compression" without loss of semantic information value (to the level of "flat" one-dimensional/ one-rank semantically-complete and semantically-correct system by def.D.0) where structural parts/component automata belonging to the system's internal structure are replaced with their equivalent Dj functional transformations'summaries corresponding to the functional variations of the whole flat entity/ zero-rank automaton's structure.

The result of such semantic compression will here be called the semantic "residuum" in analogy with the differential mathematical analysis, which also determines the minimal meaningful/ semantically significant amount of information (in entropy metrics) of the given entity in the context of its existence (as a system structure) and its component use by a next upper level hierarchical structure

Def.D7B. "Normal Semantic Constructivism" is determined as trying to create a "correct" composite/ constructed semantics of two separate (often mutually orthogonal) semantically correct and semantically-complete theories, associated with relevant mutually independent themes. Any other case generates a result classified as "fuzzy" constructed semantic Theory (as of Lemma.5A).

Lemma.L7B. "Formally meaningful and semantically correct "constructive" Theories can only be ones that:

* are built up of elementary/flat And orthogonal Theories, corresponding to Lemma.1 and Lemma.2 (i.e. well-formulated and correct/ true theories), or

** construct a complete disjunctive matrix of elements in each of the hierarchical ranks of the input theories (i.e., the output theories have the same hierarchical rank of structure as of the input component ones)

The proof of the above statement follows from the definitions of Lemma.1 and Lemma.2, according to which the lack of the corresponding element by element composition at the composite level generates "fuzziness" of the obtained new structure.

Corolary L7B (pattern of scientific evolution) Any cross-theme knowledge creation walks through 3 stages: A:"Identification" of topic/the ignoration discrimination; B:"Ideologization"-fuzzy semantic set creation with partial semantic correctness and partial semantic completeness; C:"Formalization"- normalized semantic construct achieved, granting correctness and completeness of the cross-theme new Theory by fulfilling all the gapping matrix nodes of semantic conjunction at the different rank levels

-

##5. Semantic Interaction

Semantic interaction implies the interaction of at least two entities on the basis of exchange of signals / information which these entities load with some non-zero significance. Non-zero significance means that:

1 -signal from entity A is discriminated by entity B;

2 -signal form entityA is recognized by entity B;

3 -signal from entity A is interpreted as a Not Null /NotVoid by entity B.

Semantic interaction as a concept is equivalent to semantically meaningful communication between entities/subjects.

In the particular case of signal exchange having characteristic of "white noise", there can be no interaction. That is because of the practical indiscriminability/ unrecognizability of the signal against the background of the Universe with its infinite volume of sources of overlapping signals, the resulting sum of which forms purely random,White noise. Secondly, the neutral existence of an Entity in Space can not generate a specific signal that carries a specific meaning (except the trivial one for its own existence with a practically binary information weight) to participate in it in a specific (i.e. for some super-system) interaction with another entity. Such neutral existence (with respect to the environment) should also generate the zero meaning content (or near-zero meaning content of existence) of the emanated message of the entity to the surrounding World.

Def. D8 Concept of Semantic Significant Communication

In the Weaver paradigm [Shannon1949], we talk about semantically meaningful communication of entity A to entity B only within the volume of signals recognized by the Theory (fsMb) sent by A in the context of (fsMa) which have an identical semantic interpretation of {Qx δ}a, {Qx δ}b Such communication may be partial or complete, depending on the percentage of symbols / signals in the Theory (fsMb) which have analogues/corresponding ones in the Theory (fsMa) as well as the respective corresponding analogous functional interpretation {Q x }.

The addition of semantically significant communication - semantically indifferent or semantic-zero communication – appears as the transmission of a set of signals belonging to the Theory (fsMa) that are not recognized (or interpreted correctly or not identical to the sender) by the Theory (fsMb)

Def. D9 Sustainability and instability of semantically significant communication

Semantically significant communication appears as a sustained/stable pattern of interaction between two subjects when each such signal from the Sender is recognized, interpreted, and respectively performed by the Recipient in the same way over time. This - unlike the "semantically insignificant" communication, which appears as randomly unstable one, i.e. first, when a part of the sent messages can not be interpreted by the recipient, and second when the recipient's interpretation differs (both in time and in a functional structure) from the sender's interpretation and, thus, the activity attributed to these messages can not and will not be fulfilled in the requested/ ordered type, volume and form.

The concept of sustainable/ unsustainable information communication between two entities should be seen in the paradigm of dynamic systems with a time-varying (and partly spatial) structure and, mainly, the changing volume and content of exchanged signals and the information contained therein. In particular, this paradigm covers the "communicating sequential processes" as of [Hoare1978].

In the above paradigm, we can apply R. Kalman's approach [Kalman1960] to the Wiener 's concept of multi-dimensional stochastic systems [Wiener1949]. The general case of such a sustainable complex system (designed on the two different entities in semantic communication between them) implies:

observability of every elementary (intra-structural) state (in both entities);

observability of each incoming impact/signal (between them);

knowledge of the formula for transition from an internal state to another intrinsic state under the influence of input signals, i.e.□□□: Qx□Y□Q (for any Entity in the communication);

knowledge of the formula for transformation of the desired output system state into a set of control inputs and current states (i.e.," output function" □□: Qx□YY) (for any Entity in the communication).

As a result of such a paradigm, we can observe (and predict) all stages of the interaction between the two entities by changing their states, as a result of the exchange of messages (output function for one entity, and input-transformation function for the other entity). And, depending on the set of transformation functions (for both communicating entities), this process can be consistently repeatable/ cyclic, or chaotic/unsustainable with disintegrated/ disappeared repeatability. In this context, a cyclic-repeatable interaction can be defined as a semantically significant communication, while a chaotic-unsustainable disintegration - as a semantically insignificant one

The observability of every elementary state qi T Q and every input impact wi T □□corresponds to the definition of Lemma.4 for full bidirectional/ two way semantic interoperability of two entities, respectively to orthogonalized structure of (array of) linear minimal and non-minimizable deterministic automata/FSA in the role of (complete system or specific interface component of) communicating set of distinct entities-subjects somewhere in Space.

Theorem.T1.(conditions for) sustained Semantic-meaningful communication –

* A Any (cyclically repeatable and in a semantically complete volume for the corresponding automaton’s language) sustained communication between individual entities/ automata with "flat" own semantic structure can perform semantically meaningful communication

** B A subset of signals/ terms in communication between "normally-expanded" multi-rank semantic theories of individual (complex) entities/ automata, which in the version of maximal semantic compression form a set of "flat" fully semantically-interoperable residues (i.e. in compressed form they are entirely semantically significant and can perform sustainable semantical communication), can be semantically significant and perform sustainable semantic communication

Hence the corresponding integral upper-level entities can be (partially) semantically inter-operable in such a normally expanded form. The proof of this statement derives from the isomorphic nature of the entities after a semantically significant communication has been established and in result conditions for structural orthogonality and automatic minimality and non-minimization are fulfilled...

The proof of the above statement follows once the basic condition of Lemma.5 from [Bojilov2015] and then from the conceptual structural framework under Lemma.7A, Lemma.7B above.

Theorem.T2. Semantically unsustainable communication (an alternative)

* Any pair of semantically fuzzy entities (i.e. with fuzzy set of comm. infrastructure as of Lemma.5A ‘s definition) can perform only a semantically unsustainable overall communication (in the context of Theorem.1)

** A pair of entities, one of which beeng semantically "blown" (as of Lemma.5B’s definition), but not "normally expanded/blown" (in the sense of Def.8 and Lemma.7A), can not form a two-way semantically significant and semantic-sustainable communication, except in separate, partial subsets of the signals used in the respective theories, to be interpreted in limited sub-space and time as "normal-blown"/ normally expanded one.

*** A pair of entities, one of which beeng semantically “fuzzy” by structure, forms a complex of the type of "semantically blown, unnormalized" semantics in communication with the non-fuzzy other entity, which are semantically unsustainable.

##6. Dynamic features of semantic communication

The principle of semantic compatibility, followed by semantic-meaningful communication, and finally the synchronous communication of sequential overall process as of [Hoare1978] implies more static, and even complete system compatibility of the process between two interacting entities. This – in opposite to the real partial compatibility in time, and in the functional local sequence of commanding terms and related internal transformations of the corresponding real automaton (in the volume of restricted K-equivalence of random parts of its functional structure to the appropriate ones of the counterpart automaton). Such a fluctuation of structural transformation velocity or partial observability of input signals necessitates an extension of the general task on analysis of semantically significant communication , which has to cover other parts of the automaton's functional structure, lacking such compatibility (with the counterpart automaton). In this sense, real life necessitates an additional analysis of the dynamics (both in time and, at least, mandatorilly in the functional / positional compatibility of different entities/ automata), respectively their sustainable stable states and their transition processes (where possible) of signal discrimination, signal processing, and all related functionality enabled by these signals.

The development of the previously mentioned Theory of Dynamic Systems Management by R. Kalman [Kalman1960] in the range of unobservable internal states and unobservable inputs in systems with complex structure offers a particular solution of manageability. This solution will allow partial manageability and observation of such dynamic system, provided the obscure/unobserved part (both the incoming effects or internal states and internal transformations) is stable/sustainable in time and space. Then management theory tolerates "stabilizability" and the partial manageability of the system only by observable (and therefore available to management) part. From there (by analogy) we can also look for a private solution of partial semantic interoperability as a particular case of the semantic context of a separate component of an entity/ automaton from some complete super system. This component context may be involved in building up the "general" (semantic) Theory of the (super system's) entity as a major component, especially in the case of the orthogonalisable concept architecture of the super system, and the relatively stable and very weak and slowly interacting (with the component in question) other structural components. Such a specific "private" component entity/ phenomenon/ FSA for its lifetime (!) as observable/ controlled entity with respect to its semantic interactivity/interoperability with some other external entity (i.e. another external super system rather than neighboring non-observable and slowly changing components of its own super system) should not be subject to random, or uncontrolled structural transformations or unobservable interactions with these external entities. Then it (the major component) can perform a (locally based!) fully semantic-meaningful communication with the outside world. In terms of {semantically meaningful communication}, if two super-systems A,B, have (each one) a single specific component Xa, Xb, and they interact with each other through this component, and in both cases, respectively, this component has a semantically compatible theory (such that Ax is isomorphic to Bx) , these systems can carry out semantically-meaningful communication between themselves, regardless of the semantic incompatibility of the remaining parts (Ay, Az, ... By, Bz ...)

Def.D10. Dominant component semantic significance

When in two different entities with a complex hierarchical structure in space there is a minority of components which can produce out semantically meaningful communication between themselves, against the background of a majority of components that can not make such communication, the former set implements a dominant semantic "Communicator" for its super-system.

Def.D11. Dominant component semantic power

When in entities of complex hierarchical structures, where the information processes and the signal-state connection are located in a distinct structural component constituting a dominant semantic communicator, the semantic power of this communicator tends asymptotically to the semantic power of the whole entity in the context of its interaction with others entities and the World

Lemma.L8. In entities of complex hierarchical structures with dominant semantic communicator, this component (i.e. the part !!!) functionally replaces the whole entity (ie the system !!!) in semantically significant communication with other entities of the surrounding World/ Super system.

Teleomatic component structures can not form a dominant communicator in a super-system in view of their limited structural entropy capacity. Teleonomic component structures can participate in a dominant communicator in a super system, when they possess more than one intrinsically stable structural state and can perform a transition between these (two or more) states initiated by an external signal (i.e., they can be functionally depicted as FSA with more than one inner state)

Def.D12 Local short-term semantic compatibility and communication sustainability-conditions

By "local short-term" semantic compatibility and persistence as a component-part phenomenon or a whole structure of complex entity phenomenon interacting with another similar entity, we will understand such semantic compatibility with a time-limited validity (in addition to the spatial- and structural-restricted communicator component set’s validity) which has sufficient semantic power in relation to other shorter-term internal functional processes and phenomena inside the communicating entities. This short-term semantic compatibility plays substantial role in the specific mutual relations of the above explained two super-entities and mainly in their semantically meaningful communication, which in all other external compilation proceeds as meaning-less communication

The property of a Dominant Semantic Communicator as part of the structure of a complex entity can be seen as a manifestation of local-short-term semantic significance phenomenon for such complex entity

Theorem.T3 The local-short-term semantic significance when two arbitrary entities interact does not imply a permanent (and even less - bidirectional/two way) inter-operable (as of Lemma.4) and semantic-sustained communication between these entities.

The practical application of local-short-term semantic significance (in entity-to-entity communication) is found out in the attempt to interpret the surrounding world, made up of structures much more complicated than the instrument used in the theory of FSA - simple teleonomic structures with defined initial and final state. In the real world there are also more complex "teleological" structures (as of [Hoffkirshner2010]). Their origin comes from the merging of a huge number of specific FSA in exotic constructions (Homo Sapiens is built from 70 trillions organic cells!), which are transformed into components of such a super-system, and unify in this superstructure a super-theory of their own Theories of life communication into a partially ordered (based on physical complements between individual automata-components in the multitude of neighbors) and partially chaotic interacting component’s states. In terms of these teleological entities, under the conditions of a high degree of parallelism and relatively weak connectivity (between components), we receive an excessive amount of the available semantic information, relevant to a common set of intrinsic states and functionalities and (necessarily) interacting with the diverse (but pragmatically not so valuable) environment which can be put in use in different (stochastic rather than strictly deterministic) way depending on the current state of their internal "logos". This wants to outline fulfilment of Lemma.5B conditions for abnormally inflated/blurred semantics in a non-minimal common algorithm of operation. At the same time, the choice of specific teleological/ purposeful behavior directed from such an integral complex entity to a particular moment implies the presence of the corresponding local-short-term semantic significance, linked to interaction with the surrounding world, which in only extreme and specific cases can be fully compatible/ interoperable with some hypothetical (deterministic) super-systemic semantic value/goal. In most cases this semantic significance is at the level of the mathematical average response to the neighboring component or super systems whith expressed "fuzzy" semantic value as of Lemma.5A (in terms of analyzed entity-subject relation).

Thus, the mechanism of local-short-term semantic significance opens the boundary of evolution for information-seeking systems in conditions of insufficiently stringent (semantic-informational) formalism and insufficiently high value criteria of filtration for the entities of the class of teleological structures - animals and civilizations.

Def. D13 Local Structural semantic compatibility/ interoperability.

We can define Local structural semantic interoperability of two entities/ automata (which are not structured as FSA with flat semantic theories at full/complete interface with both the world and/or between them) when:

• a) the two semantic theories (of these entities) have the same rank and the same (to zero rank and similar/ compatible to the next downstream ranks) semantic length (or similar semantic power as a FSA language);

• b) the two semantic theories are semantically “well defined” but not semantically "fuzzy" (as by Lemma.5A), ie they have full own enumerated element lists in the languages Σ;

This formally identical "visible" external structure of semantic compatibility can be supplemented by an "invisible" internal one, a common intra-component semantic context, in which each of the communicating entities:

• c) has a generic enumerable semantic zero-ranked dictionary (!!!) as a subset of the language Σ (in each of the two enumerated lists);

• d) has its own semantic inter-rank dictionary - a description of the relationship between the general term (i.e. zero level) with the set of component sub-states and the dictionary of their activation command signals/ words at level (zero-1);

Ideally such interrelated dictionaries are available for all possible differential decomposition levels down the teleonomic, and even in the terminal case - by the teleomatic type structures-components

In addition to the above conditions for complete local semantic interoperability, we can accept a bit more fuzzy definition based on the semantic Theories of Dominant Communicators/ components of the corresponding integral entities

Def.D14. Partial structural local semantic compatibility/ interoperability

We can speak of such partial structural interoperability when comparing two different "abnormally inflated" entities, for which we can deduce a semantic subset of □a, □b, which in its turn complies with Definition. 13 for local structural semantic compatibility/ interoperability.

The phenomenon is usually not related to the origin or exhaustive structure assessment of the entities/ automata, but only to their local and/or temporal mutual situation

Structural local semantic interactivity (as a property for set of entities) can be used as a preliminary eligibility criterion (!) when developing a policy of semantic interoperability between two independent (respectively ignoring each other) entities, that are expected to establish contact , and are organizing a meaningful communication between them. This approach is suitable for ex ante/ preliminary rough quantitative semantic analysis of the theories of the two entities, with regard to assessing the achievability of inquired semantic compatibility, and then the labor intensiveness of a reconciliation process.

Def.D15. Hierarchical multi-rank structural semantic compatibility/interoperability

When a given structure is represented by a (hierachy-full) multi-rank (normally-expanded) Theory (with discrete sets of functionally linked hierarchical levels of local component structure) and the corresponding multiplicity of level-specific functional transitions and states, the same can be minimally represented by a reduced number ranks (up to flat one-sided) Theory, and so compressed to be semantically interoperable with a similar compressed flat theory of another entity. The depiction of the Theory in an interim version of N-hierarchical levels can not be entirely semantically interoperable with another functional duplicate of entity, but presented in Theory of another interim version of N +2 levels/ rank, or at all N+K (KK 0 , K= 1,2,…-1,-2…) interim ranks.

The correct approach to assess the semantic interoperability of complex systems is to present these two semantically compared (and mutually communicating) entities belonging to one and the same rank of hierarchical structure (eg presented in 3 hierarchical levels each) and to describe them structurally (and functionally identical or compatible) at these levels. In this context, structural semantic interoperability in multi-level/ multi-rank hierarchical structures implies additional and rigorous ranks alignment of structuring in both communicating entities.

Theorem T4. Constructing correct Semantically significant communication (semantic interoperability)

Semantically significant communication (or binding in any aggregate image) between two arbitrary entities of a high structural order (generally teleological type) can be constructed / realized only if these entities correspond to the definition for local structural semantic interoperability (in Def.13) in a flat/ minimized functional presentation (under Def.0) or multi-rank structural interoperability (under Def.15) - in a hierarchically structured/ depicted entity.

As a consequence of the above statement (or empirical property), actually observed in multi-level complex entities (of “civilization”/teleolegical type), an attempt to successfully constructing set of complex semantically significant communications between entities of different hierarchical rank (ie, the combination of components linked to different themes in a common system) leads to success only to the level of the closest to the common zero-rank of component’s Theory normalization. It corresponds to a partial semantically significant communication and interoperability at the component’s semantic description of minimal rank. Outside this partial semantic compatibility we observe residual semantic dissonance in the mutual communications produced in the other part of the structures of complex entities. The same dissonsnce appears true if attempting to functionally construct a new Cartesian SuperCart of states and signals (of different components) or a new linear component sequence of two or many more complex entities with some limited semantic communication capacity between themselves. The success of such a construction will be limited by the capacity’s rank of the hierarchical multilateral interoperability (as of Def.15) of the corresponding states and functional transitions of the closest to the zero common rank regardless of the unilaterally delineated structure of one (component’s) entity versus the stagnating globality of the others (component’s entities)

Def.D16. Partial semantic-meaningful communication and interoperability

In case the conditions of Def.13 in full range (a, b, c, d) are not executed, and for exemple only conditions a, b are applyed for a given super-system, than it will be possible to be constructed only PARTLY sustainable communication, respectively PARTIAL functional interoperability on a subset of signals, states, functional transformations, when the communication between the considered entities-components manage to aim precisely those components

In case of hierarchical structure of the component entities, such partial communication is realized when a state from the level/ rankN of entity A is interpreted as a signal to entity B again from the level/ rank N. In all other cases, real communication can not provide a semantically significant correlation and, therefore, functional interoperability of both interacting sub-systems-entities. There is no signal of the N+ K rank of entity A to target a state of non-existent N+K rank of entity B.

##7. Interoperability

The popularity of the “mantra”/ concept for interoperability (of various, most often administrative and social structures in their role as components of a civilization’ super-system) as an approach to reduce additional interfacing synchronization services and expences (in the process of physical communication between two arbitrary entities) has its interpretation in two different directions:

-* Limited interoperability of two entities, equivalent to partial structural local semantic interoperability with respect to (a small enough for the whole) subsets of □a, □b, of these two communicating entities, each one of an arbitrary, but substantially structural complex type.

-** Full interoperability pertaining to the full structural and functional uniformity/ isomorfism of the entities, involved in the communication process, usually associated with a common industrial(!) origin and a standard functional program (Initial Program Load) of the states change from fixed inputs.

The division of the two approaches immediately makes unreal the concept of "full interoperability" applied to different administrative structures of modern public administration, either in a single EU country, or between the same types of national administrations in different EU countries. This unreality of the studied phenomenon claims that the FULL structural equivalence is impossible now and unattainable in the foreseen future.

According to the structural hierarchical classification in [Bojilov2015] or the simplified one in [Hoffkirschner2001] and the definition for teleological entities applicable to the concept of Human Being, Human Organizations, Society,Civilization, which exhibit some non-zero degree of external CHAOTIC behavior as a concequence of its teleology (i.e. they come in the class of "semantically-fuzzy" systems), we can not talk in formal manner about Full Interoperability under any conditions as this has already been predetermined, by phenomenon definition restrictions. This fact is additionally reinforced by the Theorem.T0 presented at the beginning.

We have a complete (formal) interoperability in the observed Universe only in terms of inanimate artificial, industrially-produced (by the deterministic program) objects/systems, which can only be considered as teleonomic entities with guaranteed terminal state/end of change/ reaction. For example, we can have full interoperability between each pair of T-triggers, among the items in a set of mice traps of a given size, produced by an industry manufacturer, etc. - they always respond to the same signal with only one and the same functionality.

In a group of entities, where a component of which is also Homo Sapiens (or human organizations, societies etc.), only partial functional interoperability, respectively limited interoperability is possible. This corresponds to partial structural local semantic interoperability - for that small particle of the universe, for which the respective subjects use the same glossary terms/ signals (in the context of Def.13) for one and the same functional response requested. Similarly, partial semantic inter-operability between organizations (i.e. weakly linked associations of semi-independent entities) can exist only with respect to a separate partial subset of functionality, and never in their systemic integrity as a whole super-entity. Naturally, this does not interfere with the pursuit of maximizing this partial functional interoperability in different ways, but the pragmatic realization of such maximization passes through 3 distinct phases:

A comprehensive definition of the corresponding sub-structures (as a FSA) targetting the requirements for the definition of a meaningful (i.e. semantically complete) and correct descriptive Theory

Determination of the size of the minimal and maximal mutual/bidirectional partial local semantic compatibility of the target sub-structures. Supplemental determination of a dominant semantic Communicator and its semantic power in the context of the functional significance of the studied structures' interaction, in the general target function of the super-System;

In the context of available ontologies and other formal structures - searching for limited semantic compatibility to cover the functions/ semantic length of the target Communicator (of the super-Entity).

A good example for such a partial subset is "entry of outsiders into the building of the organization" as universal formalized procedure! Next - "hernia treatment" in one organization will always be semantically different from "import of green tomatoes and turnips" in other one, so any further servicing sub-structures shall be not interoperable…

##8 Concequences

The formalism of semantic compatibility developed in the text above can be used as a basis for analysis and a serious rethinking of existing policies for interoperability even at the level of our entire modern Civilization. Some of them may be perceived more as "philosophical" although the traditional "humanitarian" approach in philosophical questions is very jalouse to the "mathematical" formal metrics

We can inquire in three major topics:

formal metrics for organizational management of evolution and their influence (A)

formal metrics for the evolution of reason in scientific and constructive direction (B)

linguistic optimization (C)

8.A.

First of all, we should underline the key hopeless direction of the demand for interoperability in general. Above we showed the principles of semantic compatibility and interoperability, and the dependence of this process on the size of the participating structures. On the one hand, we have the difficulty of formally depicting natural structures in the paradigm of semantically-complete and well-structured theories that allow the use of the simplest linear/ or orthogonal matrix FSA, which drastically limits the possibility of some effective (respectively formal) optimization in constructing complicated superstructures, including ones with the participation of a teleological component - here the concept of semantic completeness enters as the argumentation of the theorem 4 from [Bojilov2015]. Secondly, after the necessity of working only with flat semantic theories (when they are available), the problem of the complexity of the new construction (which is generally not of a flat or orthogonal structure), depends on the factorial (!!!) of the number of different elements (states or input signals) used in the FSA- structure of the target system. The cited above [Reg1089EK2010] introducing "theory" T(fsM) to Hydrology with its 65 components-entities would have a semantic power (goal of semantic compatibility analysis for semantically complete but not well-structured image), amounting to 8,25 with 90 valid decimal places before the decimal point. The story of the chess board and its price (2 in Exponent 64), which illustrates the exponential increase in complexity unreachable by engineering sciences, corresponds to 1,84 with 19 valid decimal digits before the decimal point. Or factorial complexity has more than 5 orders of magnitude greater then exponential complexity.

The story of the payment of the chessboard as an illustration of the horror of exponential grooming states that the author of the chessboard, after refusing several times the prime, finally asked the King to pay him for the first square – one wheat grain, for the second square - two grains, for the third – 4 grains etc. - a total of 2exp64 grains, which turns out to be ... about 360 cubic kilometers of wheat.

As a corolary of the above-mentioned lack of perspective, solutions for the interoperability of already completed systems/ entities should be sought only in a LIMITED SCOPE which, in order to be valid, should be concentrated to the zero rank of semantic writing of a structure of a given entity, object of search for interoperability with another similar entity. Which means a cooperative activity of (teleological type) entities in a limited semantic space, for which these entities have a capacity for full enumeration (in the context of Theorem 3 of [Bojilov2015] or at least a subset within the scope of the Dominant Communicator.

Then we enter W. Lipman's paradigm for the "excited flock" (by N. Chomsky), who has no capacity to reach the semantically significant solution (for his problem), but is already in an unstable, excited state in its universe, looking for someone to bring him the ready solution in the volume of (small and simple) Dominating Communicator set. And the ready solution - with the continuous reduction of the volume of the available "knowledgeable experts' group" - is more and more often replaced by another "flock's bellow" and its accidental interpretation as a response - truth of last resort, because there is no one to make a "semantic filter" on it. And extract the Signal from the mass of white noise environment.

Finally, when we can not overcome the constraints of the complexity of existing semantics, once in the different components, and then of complex co-ordination between them, the correct (and evolutionally-observable, e.g. in the field of applied informatics and software industry in the last half century) solution is the CONSTRUCTION of new ARTIFICIAL entities to replace existing olds, with limited (documented !!!) semantic power, common anthology, and simple functional activities, that can fit into the rules of semantic reconciliation and, respectively, easy functional communication in the context of complex structural and functionnal tasks of the super-structure.

8.B.

The problem of normalized semantic constructivism, which in pejorative form is translated as "how to construct a new truthful knowledge on formal criteria only", becomes fundamental to the modern stage of Earth Civilization behaviour. Our past history of accidental discoveries and practical verification of its regularity (in parallel with the expulsion of an exponential number of such false pseudo-discoveries) encounters today's geometric growth of individuals engaged in scientific discovery and the catastrophic lack of other individuals who, in a factorial volume should check the correctness of all these discoveries. Here arises the need of using the formalism of the pre-structural semantic compatibility of two themes, from which both a new general but correct complex theme, and the significance of such a "semantic" formalism must be constructed (hierarchically). Which make this proposal for a theory on semantic interoperability with immediate and highly valued social applicability

The case study (cited in the introduction) under Directive 60EU2007 on floods and instructions for a common flood protection policy on the (semantic) engagement on the one hand of a complex hierarchy of Flood components (duly drafted by the EU-funded hydrologists-experts) with (from another part) the collective notion of "number of injured (in some way) people" for which there is no corresponding normally expanded hierarchical semantics in detail (i.e. harm semantics corresponding to the hierarchical structure of the initial Hydrology' semantics) is not correct under the framework of Theorem.4. While the "number of injured" is a semantic substance of a rank close to zero - "nature" in the flat paradigm of "civilization", the hydrological components are at least 2 ranks lower than the group concept of "water quantities", which leads to the predicted by Theorem.4 impotence of the resulting pan-European FWG recommendation [floodReport2011] as a directive of policy-administrative implementation at the national organizational administrative level. Accordingly, the implementation of this recommendation would have a predictable common result, which would be close to nill common, and at the same time useless result.

The FWG recommendation could have a significant result if the corresponding hierarchical structure of a hierarchically developed concept of injured persons in a number of sub-stages and variants was compared to the well-detailed hierarchical structure of the semantics of hydrology with its components, e.g.:

- once: physical total death from drowning,

- second: - partial illness from wetting or initiated by a flood forced move's injuries –

- third: partial loss of wetting - damage and restoration of clothes,

- fourth:indirect Loss - From wet/ damage (RealEstate) to Owned product - economy,

- fifth: from a blocked activity - economy

- sixth: from indirect loss of emotional load – illness

- seventh: from indirect loss of emotional load - agitation and business incapacity,

- etc. etc,

as for each of the above intermediate states of hierarchical decomposition the relevant measurable component is bound to the complex content of the "flood" entity.

The above example opens wide possibilities for preliminary expertise on the achievability of a project for generation of scientific or normative-applicable knowledge, which, once imposed as a formal practice, would increase both the scientific activity in constructive and developmental spheres, and especially in the normative activity of social management, that must be performed by individuals with limited semantic capacity and, as such, with a limited precondition of creation, both in scope and complexity, and in the correctness of the result. The result of Theorem.4 leads to the rather sad conclusion, that with the gradual increase in the complexity of Civilization systems, any attempts for their meaningful, constructive and effective management made only by representatives of HomoSapiens will asymptotically go to ... total failure(!) equivalent to the purely random Brown type of non-management.

In order to overcome the civilizational “no-go” / ”cul-de-sac” sketched above, the fundamental solutions for changing both the decision-making system at national and European level should be taken as a matter of urgency, as well as an emergency literacy for all governance people based on Semantic Interoperability with a range corresponding to the elementary arithmetic literacy of secondary school. This literacy should replace the actual intuitive approach of constructive thinking of every modern intelligent person with a new, formalized framework and matrix scheme, that would radically raise the effectiveness of this constructive thinking by using filtering practices through prior expertise for reachability and truthfulness.

8.C.

Consequences from rules for attaining a formal semantic compatibility between entities have some important (classic) linguistic meaning. They would also apply as a rule of excellence, at first on natural languages's semantic expansion/inflation to modernize civilization on Earth, and at second as justified direction of evolution in language improvement with the goal of overcoming a curse on the factorial complexity in the semantically significant communication between subjects speaking these languages. The dramatic lexical increase observed in the last 2 centuries in the space of basic semantic items (i.e., an increase in the number of different words/ terms in the vocabulary of the Civilization and in communication with Homo Sapiens in the super-system - until recently in the industrial, and now in the "post-industrial" – the Information-Infrastructural Civilization in the majority of modern national implementations) - leads to a steady increase in requirements for the use of this language component of the super-system. As per exemple the Princeton University's English language base (WordNet) in the US has already reached 117,000 individual atomic words - entities by 2012. Such uncontrolled increase in the volume of language leads to a relative big increase in the volume of the "excited flock" (from the organisationnal management chalange thematics) as compared to a decrease in the volume of the "knowledgeable experts group" (as of the mentionned above W.Lipman's social paradigm), on the basis of which the asymptotic "disappearance" of this group of knowledgeable experts is a matter of time, rather than matter of principle - because of the simple congestion of inter-individual semantic-meaningful communication.

Secondly, there is an increased localization effect on languages, associated with local-temporal semantic significance (replacing the basic K-equivalent semantic consistency), which is leading not only to the spatial-local dialect of a given linguistic multitude, used by a given local population (urban X- or Y-area residents, or administrative Z- area), but mostly to a spatial-functional argot/slang, from there to a thematically different slang of different(!!!) semantic lengths of the sets, which, in the context of the language common to the population of a given civilization transform the inherited language (with stable semi-minimized neolyte semantic structure) to a new state of exponentially expanded fuzzyness set in the context of semantic structural weight. From there – follows super-system decreasing observability, communicability and controllability, respectively, super-system manageability decreasing and system degradation/ death.

Third direction of both fuzziness and semantic inflation of the inter-component communication paradigm is the specific weekness of each modern natural language - its idiomatic and/or phraseological application subset (for “English” – more than 10000 idiomatic items, for “Francais” - of France, Canada, Switzerland, Belgium – up to 30 000 terms of appr..60 000 total language set [Lamiroy at all2010]), as well as its different local dialect applications. The idiomatic and phraseologic inflation of a given language is very good for literature content development, but it is fatal for science definitions or for regulation specification in the modern civilization super-system behavior. The continued use of popular natural languages in the modern expansion of civilization makes inapplicable the above presented formal semantic paradigm and theory, because of unattainability of both local partial and hierarchical normalized semantic interoperability in systems, based on spoiled by idiomatic, phraseologic and dialect-enabled languages for inter-component communication both for Industrial’s and HomoSapiens’ componets. The possible deadlock exit is both in defining NEW artificial language with high degree of formalism, or substantial ’reengineering’ of popular natural language with large thesaurus , formalized minimalist grammar, no idioms/phraseology. At the moment the commonly used World-wide English language corresponds only to the first requirement – big thesaurus.

In terms of semantic-structural blurring of a given language as a global system of semantically meaningful communication between individuals - components of civilization, in the foreground the meaning of the Dominant Communicator is re-emerging - the minimum common sub-set for all semantically important elements on the basis of which to maintain the backbone of semantically meaningful communication. However, if the English language as well as the entire modern languages group based on a phonetic alphabet, is more or less reachable for an individual possessing this alphabet and correspondingly this thesaurus volume of Dominant Communicator for a given space or functional theme, such statement can not be applied to languages, based on hieroglyphs and symbol-word sense matching. The basic disadvantage of hieroglyphic communication is well understandable for every telecommunications and coding expert (in the context of two-level identification of input language –as symbols and set of simbols-words): If the phonetic alphabet uses 20 to 40 characters that are easily STANDARDIZED and memorized by humans (and machine-identifyed actually), then a hierarchical assembly of phonetic symbols is used to generate practically endless quantity of combinations – words to be visualized/memorized, the hieroglyph writing once faces the problem of the difficult standardization of the large number of hieroglyphs (for the Neolithic agricultural culture - over 1000), and secondly, the problem of "normal expansion" of such information framework used by the appropriate civilization, the necessity of a very heavy procedure for introducing new hieroglyphs to designate new entities that do not intersect with the old ones' images, and which should become widely known and easily interpretable even for newbies. The hieroglyph-based language does not support parallel thesaurus expansion in the manner the phonetic alphabet language does. The second part of the problem explains the slowdown of the industrial revolution in China, Japan and Korea since the end of the 19th century, and the creeping of China at the time of Mao's "cultural revolution" alongside the intensive technological growing of neighbors from the Socialist camp.

The majority of the hieroglyph-based languages disappear at the level of the early and middle Neolithic civilization. The latest civilization cultures go outfrom hieroglyph in the bloom of the industrial phase - Japan switches to a phonetic alphabet in the middle of the 20th century, and South Korea - at the end of 20th century. As a result, their national civilization performs unprecedented cultural and technologic acceleration and is currently around the leadership of Earth Civilization. The only exception - China - has not yet escaped its heavy hieroglyphic system (currently with more than 50,000 characters), despite the arrival to leading place in the economy of world civilization. Rapid progress over the last 30 years is due not so much to the Chinese culture as a basis, but to the Latin alphabet and the English language, that any Chinese self-respecting scholar or technocrat knows (and today's educational system is instilling from the third grade for every boy and girl) as a platform for learning and creating new knowledge.

The hieroglyph language literature is a nightmare for machine reading, so possible human-machine interface for semantically interoperable multi-rank communication based on hieroglyph signals should be a nightmare too. However, the experience of leadership based on the Chinese culture in question and its hieroglyphic basis will certainly fail, except in the case of the rapid creation of a new phonetic alphabet specific to the Chinese language group and its urgent implementation as the basis for a new Dominant Communicator, first for the new generation of Chinese, and gradually for all other intellectual and productive generations of citizens of the UnderSky Empire. Only then China could really take the leading rudder of the next civilization phase of the Earth ...

Acknowledgements

I would like to thank Y. Zlateva, which helped my English translation to become more readable.

The paper is published with partial support by the project ITHEA XXI of the ITHEA ISS (www.ithea.org).

Bibliography:

[Gruber,1993] Gruber Thomas "Toward Principles for the design of Ontologies Used for Knowledge Sharing" IWFormal Ontology Padova 1993

[McCarthy&Hayes,1969] McCarthy J., P.Hayes "Some philosophical problems from the standpoint of artificial intelligence" in \Meltzer&Michie edt: Machine Intelligence 4, Edinburg University Press

[Genesereth&Nilssen, 1987] Genesereth Michael R. ,Nils J. Nilssen Logical foundations of Artificial Intelligence San Mateo CA: Morgan Kaufmann Publishers

[Shannon,1949] Shannon, C., Weaver, W. “The Mathematical Theory of Communication”. Univ. Of Illinois Press Urbana 1949.

[Skolem, 1922] Einige Bemerkungen zur axiomatischen Begründung der Mengenlehre. In: T. Skolem. Selected works in logic (ed. E. Fenstad), Oslo etc: Univforlaget. 1970.

[Gödel, 1931] Gödel K. “ The formally undecidable propositions of Principia mathematica and related systems I. “In: K. Gödel. Collected Works. Vol. I. Publications 1929 – 1936. Oxford: University Press, New York: Clarendon Press □ Oxford, 1986

[Floridi, 2003] Floridi ,Luciano. “From Data to Semantic Information “ Entropy 2003, 5, www.mdpi.org/entropy

[Hofkirchner, 2010] Hofkirchner Wolfgang. “UnifiedTheory of Information-an outline - 20 Questions for a Colloquium BITae : Can a Unified Information Approach be achieved” 2009 Colloquium BITae, BITrum Project: Intedisciplinary elucidation of the Information Concept

[Hoare, 1978] Hoare C.A.R. "Communicating Sequential Processes" in Communicatuins of the ACM Vol 21 No 8 August 1978

[Kalman,1960] Kalman Rudi. " On the General Theory of Control Systems" IRE Trans on Automatic Control vol 01 1960.

[Dec922/2009/EC] Decision 922/2009/EC of the Eurtopean Parliament and the Concil on Interoperability solutions for European public administration (ISA) sep. 2009

[floodReport2011] WGF & WaterDirectors Warsaw meeting 9.11.2011 "Final (15) draft reporting sheets for the Flood Risk Management Plans" ed. M. Braettemark, J. Romero (DG ENV) ec.europa.eu

[dir60/2007/EU] –Directive 2007/60/EC of the european parliament and the council on the assessment and management of flood risks.

[reg1089/EC/2010] –Commission Regulation (EU) No 1089/2010 implementing Directive 2007/2/EC of the European Parliament and of the Concil as regards interoperability of spatial data sets and services

[Euzenat,2001] Euzenat.J "Towards a principled approach to semantic interoperability". Proc. IJCAI 2001 workshop on ontology and information sharing, Aug 2001, Seattle, United States.

[Masolo,2010] Masolo C. "Understanding Ontological Levels" Proc of 12 Int. Conf. on the Principles of Knowledge Representation and Reasoning (KR 2010)

[BernesLee ,1998],. [BernersLee, 2001] T. Berners-Lee, J. Hendler, O. Lassila (2001), The Semantic Web, Scientific American, May 2001, pp. 28-37. http://www.scientificamerican.com/2001/0501issue/0501berners-lee.html

[Hopcroft & Ullman,1979] Hopcroft J. J.Ullman " Introduction to automata theory, languages and computation" Addison-Wesley 1979

[Arbib,1969] Arbib M. "Theories of abstract automata" Prentice-Hall 1969

[Kalman& All ,1969] Kalman.R. P. Falb, M.Arbib,"Topics in Mathematical system Theory" MCGraw-Hill Book Co 1969*in russian Мир 1971

[Wiener,1949] "The extrapolation, interpolation and smoothing of stationary time series" John Wiley&sons Inc 1949 New York

[Bojilov,2015] Venco Bojilov, „Formal Theory of Semantic and Pragmatic Information - a Technocratic Approach“ IJITA Vol 22 №4 2015

[Gödel, 1931] Gödel K. “ The formally undecidable propositions of Principia mathematica and related systems I. “In: K. Gödel. Collected Works. Vol. I. Publications 1929 – 1936. Oxford: University Press, New York: Clarendon Press – Oxford, 1986

[Pereslegin,2004] https://e-libra.ru/read/169659-stat-i.html „Конструирование будущего 2004“ из „Сергей Переслегин-Статии“

[Pereslegin,2008] https://public.wikireading.ru/174903.html „Через Постиндустриальный барьер“

[Lamiroy&all,2010], Les expressions verbales figées de la francophonie: Belgique, France, Québec et Suisse, B.Lamiroy at all 2010 KULeuven

[Chen,1976] Chen Peter Pin-Shan The Entity-relationship Model –Toward a Unified view of Data, ACM Trans.DatabaseSyst Vol1 No1

Authors' Information

Venco Bojilov
e-mail: *vbojilov@bulstrad.bg*, *patilan_bojilov@hotmail.com*
Major Fields of Scientific Research,*: Distributed Data Bases, General Information Theory, Cognitive Science, General System Theory, Natural Risk and Risk Management theory*

ABOUT ONE PROBLEM OF THE E-EDUCATION

Krassimir Markov

Abstract: *The Knowledge Markets are special kind of payable information exchange. At the (electronic) knowledge markets one can buy only the knowledge information (e-) objects, but not the knowledge itself. The need of specialized (e-) education rules and standards as well as the need of laws for corresponded responsibility are pointed out in the paper.*

Keywords: *Knowledge Market, Payable (e-) Education*

Introduction

The COVID-19 pandemy caused the new grow of the on-line education. In many cases, it was the only possible solution with serious positive impact on the society. In the same time, some problems were detected. One of them is discussed in this paper.

Before 1994, the Internet was in essence a "free" medium, characterized by an open sharing of information, without regard to the commercial possibilities of digital publication. The development of the graphical Web browser, combined with the steady increase in access speed, produced a much wider interest in the medium, expanding the user base far beyond the original circle of academics and hobbyists. The first commercial web sites and "dot.com" companies appeared not long afterward, though many lacked (and still lack) viable business models for making money online. In the late 1990s, the most common approach was "Let's just get online now and we'll figure the money stuff out later". Since the spring 2001 downturn in technology stocks, the level of interest among commercial enterprises for all things digital has become substantially cooler, and many companies have retreated to a more conservative position, either scaling back or canceling their online ventures entirely [NLC, 2004].

For many print publishers thinking about expanding into digital publishing, the current "wait and see" atmosphere comes as something of a relief. Selling books is a difficult business at the best of times; adding the expense of producing simultaneous digital editions without the presence of any clear solutions for the problems surrounding rights and licensing and secure distribution of digital publications is prohibitive for many publishers. On the other hand, some publishers have found that capitalizing on the general aura of excitement surrounding new technology by producing digital publications on a limited scale has boosted the sale of their print titles.

For other types of publishers, though, commercial success isn't an issue. Many individual writers, small magazines, specialized small presses, non-profit organizations and government departments have found the digital realm to be ideally suited for their purposes. Digital publications can be produced and circulated relatively inexpensively, and can reach a readership far wider than small-scale print publications. And beyond the selfish notion of "publicity", many publishers see the process of creating broader access to texts of all sorts as a public good [NLC, 2004].

The development of new training structures should take into account features of transition to a new stage of development of the society. Education in the global information society will be a direct successor of the already existing educational forms and structures, and at the same time, it dialectically will change the forms and contents of the working patterns of training [Markov et al, 2000], [Ivanova et al, 2005].

From customers' point of view, it is difficult to discover what really will be received if one will buy an (e-) education. Many times, the title and announcement of the courses are not equivalent to their content, but the customers could not claim the damages.

This paper is aimed to outline this problem. The main characteristics of the information markets and the knowledge markets are presented. The payable (e-) education is discussed and the need of corresponded rules and laws for claiming the damages caused by payable (e-) education is substantiated.

The Information Market

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: everyone will need diverse and qualitative (from his point of view) information, but also he will not be able to receive all of the necessary information. The enterprising experts will accumulate certain kinds of the information and will provide the existence through favorable 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 over all other market activities.* In other words, the Information Market dominates over all other types of markets of the information society. Of course, the electronic education pays significant role at the scene of the Information Market.

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 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 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"* commonly is connected to concepts "understanding" and "familiarity gained by experience; range of information" [Hornby et al, 1987] or "organized body of information" [Hawkins, 1982].

From point of view of the General Information Theory, *the knowledge is a structured or organized body of information models, i.e. the knowledge is information model, which concerns a set of information models and interconnections between them* [Markov et al, 2006].

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

The 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 organized aggregate of participants, who operate according to 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.

Basing on the analysis of the present approaches of collecting, processing, storing and transferring of the knowledge, and taking into account the open knowledge environment's basic characteristics, we can build a generalized scheme of the knowledge market, which reflects the information interactions and connections between the knowledge market's participants.

The first task in analyzing the knowledge market is clarifying its basic components and the interactions between them. The knowledge market structure is formed by a combination of mutually-connected elements, which work in the simultaneously sharing joint resources.

The Payable (e-) Education

In 1990 the US National Science Teachers Association (NSTA) published "Criteria for Applying Distance Learning to Science Education" as an NSTA Position Statement [NSTA, 1990]. In this statement, the terms "distance learning" and "distance education" interchangeably apply to schemes where the learner and the source of instruction are in different locations.

Distance learning has considerable history in the education. For decades, correspondence courses have linked sources of instruction to remote individual learners through exchange of printed materials by mail. Also, radio and television have been used for a variety of distance learning schemes involving virtually all disciplines. Within science education, an early example of distance learning involved delivery of primary instruction for high school physics in the form of 16 mm films which were mailed to be shown daily in classrooms. Later, but before communications satellites were highly developed, another distance learning project had televised science instruction beamed to classrooms from a high-flying airplane. Such early forms of distance learning were limited by a low degree of interaction between learners and sources of instruction.

Recently, a variety of distance learning schemes have arisen that use electronic ways of linking the learner and the source of instruction with increased interaction between them. For the purpose of this position statement - to ensure high quality when distance learning is applied to science education - the definition of distance learning rendered by the U.S. Department of Education is adopted:

"The application of telecommunications and electronic devices which enable students and learners to receive instruction that originates from some distant location. Typically, the learner is given the capacity to interact with the instructor or program directly and given the opportunity to meet with the instructor on a periodic basis."

Rapid advances in communications technology are causing a dramatic increase in applications of distance learning to all levels of science education. Today, students from elementary school through college have high probability of encountering some form of distance learning as a primary or supplementary mode of instruction in science sometime during their school years. Also, applications of distance learning to the continuing education of science teachers are increasing. It is likely that distance learning directed toward science education will continue to expand and evolve [NSTA, 1990].

Schar and Krueger define computer aided learning (CAL) as "different forms of computer-mediated teaching methods in which the student is paired with a computer as virtual teacher". Students can benefit greatly from information presented through different types of media – this could increase their attention, and stimulate them to think about subject matter in different ways. On the other hand, CAL enables learning at home or at workplace, which saves time and efforts [Schar and Krueger, 2000].

The global systems give an opportunity for each state to use information service for an effective utilization of personnel potential of qualified teachers with the help of remote connection. Besides, it is quite possible in conditions of the global information society to fill up information resources in libraries and local centers of information service through remote access to global cultural and science centers [Markov et al, 1998].

Examination of the market demand for various types of courses and training modules is a key criterion for effectiveness and high efficiency. Market trends, industry requirements, and companies training needs have to be examined on a regular basis.

The usual talk is that in the payable (e-) education one can buy knowledge. But, from our point of view, this is not so correct.

In the beginning of the XX-th century the great Bulgarian poet Pencho Slaveikov wrote: "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."

If one buys a candle what does he really buy – the "wax" or the "light" of the candle? The light is not for sale in the store… But one really may see the example how the candle works and how it may be used. Based on this he may decide to buy the candle. At the end, if the candle could not be lighted the customer may claim to receive his money back. This possibility is very important and it is supported by the laws.

Let consider an example. 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 (e-) textbooks as well as the (e-) courses are not concrete information for building concrete house, but they contain the information needed for creating such plans. The courses written by the lecturers in the architectural academy are special kind of “information objects”, which contain special generalized information models. They are “knowledge information objects” which have been sold to the students.

So, 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!

This way, we came to the main problem we need to point – in payable (e-) education the authors and publishers as well as the lectures and tutors are not responsible for what they sold to the customers.

The employees (learners) could not claim the damages caused by the payable (e-) education but they are be responsible for the damages they have caused to the employers!

Conclusion

From customers' point of view, it is difficult to discover what really will be received if one will buy an (e-) education. Many times, the title and announcement of the courses are not equivalent to their content, but the customers could not claim the damages.

The payable (e-) education needs to be regulated both by specialized international lows and rules and by social activity co-ordinated by government and non-government organizations.

Let point that the main goal of the Knowledge Markets is to serve corresponded forms of long live and (as a rule) distance education. It is very important for the society to support and control the correctness of knowledge which is aimed to be sold.

The “freedom of information” may be dangerous.

Acknowledgement

This work is partially financed by project **ITHEA-XXI** of the Institute of Information Theories and Applications FOI ITHEA.

References

[Gladun, 1994] Gladun V.P. Processes of knowledge dicovery. Sofia, Pedagog 6, 1994. ISBN: 954-8249-06-5. (in Russian).

[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] Ivanova N., K. Ivanova, K. Markov, A. Danilov, K. Boikatchev. The Open Education Environment on the Threshold of the Global Information Society. IJ ITA, 2001, Vol.8, No.1 pp.3-12. ISSN: 1310-0513.

[Ivanova et al, 2005] Ivanova Kr., N. Ivanova, A. Danilov, I. Mitov, Kr. Markov. Basic Interactions between Members of the Knowledge Market. Proc. of the International Conference "Knowledge-Dialogue-Solution", 2005, Varna, Bulgaria, Vol.2, pp. 638-648.FOI-Commerce, Sofia, 2005, ISBN: 954-16-0033-6.

[Markov et al, 1998] Markov Kr., Kr. Ivanova, I. Mitov. An approach to the information service of the education. NITE-98, AGTU, Astrakhan, 1998, pp. 51-56. (In Russian).

[Markov et al, 2000] Markov Kr., Kr. Ivanova, I. Mitov. The Information Society. ITA-2000, Bulgaria, Varna, 2000

[Markov et al, 2002] Markov Kr., Kr. Ivanova, I. Mitov, N. Ivanova, A. Danilov, K. Boikatchev. Basic Structure of the Knowledge Market. IJ ITA, 2002, Vol.9, No.4, pp.123-134. ISSN: 1310-0513.

[Markov et al, 2006] Markov Kr., Kr. Ivanova, I. Mitov. The Staple Commodities of the Knowledge Market. IJ ITA, 2006, Vol.13, No.1, pp.11-18. ISSN: 1310-0513.

[NLC, 2004] National Library of Canada. Electronic Publishing: Guide to Best Practices for Canadian Publishers. National Library of Canada, Ottawa, 2001. Updated: 2004. http://www.nlc-bnc.ca/9/13/index-e.html , http://www.collectionscanada.ca/obj/p13/f2/01-e.pdf

[NSTA, 1990] US National Science Teachers Association. Criteria for Applying Distance Learning to Science Education. An NSTA Position Statement. 1990.

[Schar and Krueger, 2000] Schar S., H. Krueger. Using New Learning Technologies with Multimedia. IEEE MultiMedia, July-September, 2000. pp 40-51.

Authors' Information

Krassimir Markov, Prof. Dr. *– Director of the ITHEA Institute of Information Theories and Applications; P.O. Box: 775, Sofia-1090, Bulgaria; e-mail: markov@ithea.org*

Major Fields of Scientific Research*: General theoretical information research, Multi-dimensional information systems*

TABLE OF CONTENT