An Architectural Approach to Cognitive Information Systems

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Abstract: The fast changes in information technology and business needs have led to the evolution and development of Cognitive Information Systems (CIS). There have been few pieces of research on the general model for the analysis and design of CIS. This paper attempts to create a design scheme for incorporating the various models for CISs and Understanding-based management systems (UBMSS). The components that have been examined, create elements of CIS analysis and design, however, they were not described as modeling elements and not described as enabling tools needed to create a consistent and integrated system. The most significant components for modeling are: semi-structured documents, business processes, constituents of knowledge management, the enterprise and the information architecture, including self-directing software components - Artificial Intelligence (AI) - that yield functions. For CIS modeling, the above-mentioned elements were combined into a unified framework, that follows the object-oriented paradigm and architecture approach. The aim of the research is to describe a framework that presents an overarching model and assists our understanding of the properties of CIS and UBMSS, allowing the formulation of a practical development method for CIS and cognitive management systems.

Keywords: architecture of cognitive systems; UBMSS; management supporting systems; zachman architecture

1 Introduction

In the past, there was a profound evolution in the use of information technology within companies. Information Systems (IS) architectures have been developed out to depict and to maintain the several layers, tiers and components of the architecture. IS architecture synthesizes facets of systems by defining views and viewpoints that can be realized by various models described in various methodologies for information systems analysis and design. The theory of Cognitive Infocommunications by Baranyi et al. [2] [3] [4] has pointed to various aspects of IS, human-computer interactions, and gives a newly available approach of IS. The concept of Cognitive Information Systems can be perceived as an interdisciplinary area of Information Systems and Cognitive Science. Modeling, analyzing, and designing information systems by the most modern approaches provide opportunities for the application of architectural and design methodologies that unite the development methods of systems and theories of Cognitive Science [2]. We perceive the architecture of information systems within companies according to Zachman [31] and the TOGAF approaches [16]. The evolution of technology in the realm of information systems can be seized by the notion of Data Science and semantics. There is a classification of cognitive information systems as understanding based cognitive systems (UBCCS, Understanding Based Cognitive Categorization Systems) [22]. Within that categorization, there are enterprises and management related systems as UBDSS (Understanding Based Decision Support Systems), UBMSS (Understanding Based Management Support Systems). The case studies referenced publications in the form of a proposal for developing systems investigate single, double and multifactor analysis approaches that use Net Present Value (NPV), Internal Rate of Return (IRR), and discount rate [22]. The presented approaches are based on formal languages, that describe building blocks for cognitive analysis that can be considered as semantic analysis that is based on logical predicates in the form of rules and concepts. The toolset that is utilized in this approach is grounded in finite state machines, automaton and theories of formal languages to deduce the assessment of the formalized situation [11]. In addition to the systems with single-factor analysis (IRR, NPV), there is a description of systems with dual and multi-factor analysis. All the proposed systems pursue the same methods, i.e. defining a grammar, capturing the essential concepts in terminal and non-terminal symbols within the grammar, and predicates of decision making are formulated as rewriting rules of the grammar initiating state transitions within the realm of analysis. [22]. The basic version of the UBMSS have been refined further into several sub-classes, namely UBMLRSS (understanding based management liquidity ratios support systems), UBMPRSS (understanding based management profitability ratios support systems), UBMARSS (understanding based management activity ratios support systems), UBMFLRSS (understanding based management financial leverage ratios support systems) [23]. All of them use balance sheet and profit and loss data, out of extracts from the general ledger and data from various sub-systems. This data set is used in creating Business Case, Strategic Business Plan and in credit requests from banks. These data play an important role in the life of a company and its future, these data serve as a basis for further decision making, therefore the availability and appropriate elaboration of data generates and improve the value of the enterprise.

Molnár et al. [20] were to elaborate a model framework for an Information System considering the various technological and software architectural solution. The current research attempt to elaborate on a modeling framework for CIS considering the various architectural and technological components and solutions. The proposed model shows how the earlier created methodologies and methods for analysis, design, implementation, and management can be used to construct

CIS in a framework to combine various perspectives and aspects to create a comprehensive model including the relevant aspects of CIS, based on the model a methodology and related methods.

2 What Makes CIS & what is UBMSS?

CIS according to Hurwitz: "Three important concepts help make a system cognitive: contextual insight from the model, hypothesis generation (a proposed explanation of a phenomenon), and continuous learning from data across time"[13]. From the other viewpoint, Wang postulates that a "denotation mathematical" approach is required that own structures, tools, and methods beyond the traditional mathematical logic [28]. Ogiela collected areas of application of informatics and information technology where cognitive information processing techniques are incorporated into various systems [22]. Extending the definition based on the examined publications, the ideal CISs, other than the predefined details which are, contextual insight from the model, hypothesis generation (a proposed explanation of a phenomenon), and continuous learning from data across time, should impact the carbon agent cognition, in a positive way, improving it, leveraging the synergy originated from the interactions between silicon and carbon agent. This synergy generated leverage expressed via cognitive resonance. The cognitive resonance orienting the entire process to the automated data understanding meanwhile extracting the semantic information, which supports the interpretation of the understanding [21]. The cognitive resonance is a synergy with a positive impact generated by HCI (Human-Computer Interaction) that embeds the Cognitive Infocommunication into itself as a tool and as a channel. Utilizing the biological analogy, the Cognitive Infocommunication ensures that the information as a stimulus arrives at the receptor that operates as a sensor, or as a sensory organ. It is capable to exert an impact on the system and the system reacts through responses. The stimulus is either information or raw data that are transmitted, between the parties playing roles in the action of the infocommunication that improve the cognizance of both sides during HCI. The data stream that is realized by Infocommunication, can be represented as a bidirectional channel. The cognitive resonance supports the sensed data extraction and the semantic understanding. Both parties via HCI might become the initiator of the stimulus or might be a receptor or a sensor, at the same time.

According to Vincente Raja, ecological psychologists have developed concepts of dynamic systems theory (DST) as a preferred explanatory tool for the agent-environment interactions [26]. Based on our concept, it shows some similarities to the previously described acts of Cognitive Infocommunication, to its roles, as well as the cognitive resonance, however, this needs further research to analyze the similarities and discrepancies.

In line with our understanding described above CIS cannot exist without the capability of adding value, improving processes of understanding. The concept of cognitive resonance is one of the attempts that try to make sense of the modeling activities in the most recent world of data analytics that uses tools out of data science. According to Lemieux as society moves into the era of cognitive systems in which more decisions are by intelligent machines or humans working in collaboration with intelligent machines, it becomes increasingly important to consider how we will build accountability for decision-making into such systems [18]. The information architecture that can provide an opportunity for creating a framework to describe the information exchange between the human parties along with her/his supporting silicon agent and cognitive information systems can be grounded in Enterprise Architecture, and LIDA [16] [31], [17]-[8]. The advantage of the LIDA model as architecture is that it focuses on the cognitive processes and their structure at both conceptual and computational levels [7].

3 UBMSS versus CIS in Light of Zachman Framework

Zachman's framework contains the various business perspectives as different viewpoints of stakeholders. The perspectives identify the layers of the architecture. The aspects embody the distinctive modeling approaches. Expanding the Zachman framework [31] with cognitive elements supports cognitive architecture, therefore improve the system under consideration up to the cognitive level.

The contextual perspective's basic requirement is to be able to identify the goal of the system to be developed. In case of UBMLRSS (understanding based management liquidity ratios support systems), UBMPRSS (understanding based management profitability ratios support systems), UBMARSS (understanding based management activity ratios support systems), and UBMFLRSS (understanding based management financial leverage ratios support systems) the goal is the support of management in issues that are related to ratio calculation.

In the conceptual layer, the concepts, which appear within the contextual layer are fragmented due to partial ratio analyses in the financial environment, do not fulfill its goals on the business level, therefore, do not fits into the enterprise model. In practice, the analyses will not bring any added value, which is essential in the case of a cognitive system. Therefore, in this case, the correct conceptual perspective should be a system for ratio analysis that brings additional added value along with business intelligence, via cognitive resonance, that would be covered in detail by the various aspects.

Table 1
A mapping semantically between Zachman architecture and CIS's components

Aspects / Perspectives	*what*	*how*	*where*	*who*	*when*	*why*	
Contextual	Fact, business data / for analyzes with cognitive resonance	Cognitive Business Service with the synergy of the cognitive resonance	Chain of Business Process, Workflow	Business entity, function	Chain of Business Process, Workflow	Business goal	Scope
Conceptual	Underlying Conceptual data model / Data Leak structured and unstructured	Cognitive Service with added value originated by the cognitive resonance	Service composition with cognitive business intelligence	Actor, Role	Business Process Model	Business Objective	Enterprise Model
Logical	Class hierarchy, Logical Data Model [A] structured, semi structured and unstructured	Cognitive Service Component	Hierarchy of Cognitive Service Component	User role, service component	BPEL, BPMN, Orchestration	Business Rule	System Model
Physical	Object hierarchy, Data model	Cognitive Service Component	Hierarchy of Cognitive Service Component	Component, Object	Choreography	Rule Design	Technical Model
Detail	Data in DBMS	Cognitive Service Component	Hierarchy of Cognitive Service Component	Component, Object	Choreography, Security architecture	Rule specification	Components
Functioning Enterprise	Data	Function	Network	Organization	Schedule	Strategy	

The idea of CIS is to make available a Cognitive Information System embedded into business and the organizational environment through Web technology. For that reason, the model and design methodology should consider the socio-technological environment, moreover, the Web and the software engineering approaches to enhance the system with modern data analytical solutions and amend its functionality, namely:

- Computing on the Internet, to ensure the system availability supporting business continuity
- Distributed transaction processing
- Knowledge management
- Set up various KPI's (Key Performance Indicators) in line with the business process
- Set up various clip levels - build in automatized approval levels, to support the management decision with relevancy related to the decision-making process and simplify the process itself

- Identify drivers and value-added models - for example, Du Pont Modell - into the integrated ratio analyses - that would ensure a business intelligence and deeper explanation and understanding of the analysis
- Develop additional aggregated analyses - simplified format - to support management with accelerated process flow, and with accelerated automatized, semi-automatized decision
- Add additional information to the analyses related to the industry - industrial risk identifier - industrial beta (P)
- Build-in data visualization to support the understanding of the analyses
- Capture a record of reasoning and decision-making for further decision making

Consider intranets and extranets and integrations, to support data availability and business continuity, knowledge sharing, data integrity and orchestration:

- Add additional information from internal sources, DB's (databases), etc.- payment history, order history, information from ERP and/or CRM, etc.

XML / HTML documents either as Web pages or information resources, - adding additional external information from international and/or local credit rating organizations - Moody's, Fitch etc.-, to ensure updated market information integrated into the analyses, improving quality of analyses:

- Database management systems and data warehouses, tracking, saving and in case of need sharing results
- Document management systems
- Enterprise Architecture, Service Oriented Architecture, Web services, micro-services
- Identify events-based triggers within the organization and inform cross functions via messaging
- Business processes analysis and management of the Web site - online business processing
- Business process analyses support with KPI's: customer satisfaction, cycle time, etc.
- Information Security: integrity, confidentiality, accuracy, availability, timeliness - information infrastructure
- Performance and scalability issues

On aspects level, to fulfill the CIS requirements related to the cognitive resonance, where the cognitive resonance is to be integrated into/between the two aspects, that would ensure the continuous improvement of the cognitive level of the information system.

The logical model to be built without fragmentation, the integration would ensure the appropriate level of cognitive resonance.

The physical and the detailed specification layers are to support the above layers according to the scope and the enterprise and system model.

As perceived by Molnár et al. [20] Enterprise IT Architecture as the suite of strategic and architectural disciplines that includes the Information, Business System, and Technical Architectures [20].

Business (systems) architecture - Defines the structure and content (information and function) of all business systems in the organization [20]. UBMSS Systems are currently lack of structure and content definition from that point of view, that might strongly question the capability for management support that is the partial scope of the system.

Information (or Data) Architecture - represents the main data types that support the business; furthermore, the structure (including interdependencies and relationships) of information required and in use by the organization [20]. The fragmented information architecture causes limited support, interdependencies and relationships within ratios are not visible, therefore the result of the analyses with UBMSS doesn't fulfill its scope.

Application Architecture - defines applications needed for data management and business support; the collection of relevant decisions about the organization (structure) of a software system, and the architectural style that guides this organization [20]. As the above reason decision support does not cover the management support requirement in case of ratio analyses, missing an integrated overview on results and reasons, the system is not able to predict based on the data analyzed, the cognitive resonance is missing, therefore the added value is missed.

4 Reality and Expectations Form CIS in the Enterprise Environment

Essential to make it clear that what is the expectation from CIS. There are various non-solved, or partially solved constraints on CIS, therefore the goal of CIS architecture must be clearly defined. Improvisation, new hypothesis generation, and testing were unrealistic expectations, thus those are still human capabilities. A human can observe and learn new knowledge from the environment, as it is the human capacity to interpret them appropriately. However, researchers formalizing unsolvable problems, try to find a solution with CIS / AI capability to answer and / or build a future CIS capable of solving problem without resource in a creative manner in an intuitive way with improvisation is currently not the reality, as CIS needs to leverage various heuristics and other assets and experiments to be able to solve the given problem [27]:

- Related to capabilities and abilities
- Impasse detection - to be able to evaluate the current situation versus capabilities and abilities [1]
- Domain transformation and problem restructuring - in plan task revision has formally examined the effects of changing the state, including the goal, and the operators [9] [10]
- Experimentation, learning form interaction with the world, considering exploration and reinforced learning [11] [25]
- Discovery detection - to be able to solve problems in case of unexpected events, with intelligent reasoning demonstrating autonomy. [27]
- Domain extension - to be able to know how and when to absorb new knowledge form the given domain [10]

Parts of the problems were solved, however, there aren't exist CIS capable to answer a complex challenge where all of the above -listed features are needed at the same time. CIS development more focused on specific tasks in specific domains, therefore the usability is limited and specific. Due to the above fragmentation, there is a need for orchestration of the already existing technics and solutions.

Considering a strategic decision that makes humans capable to build from a complex environment their observation - based anticipations into a decision - making process, transforming it as a potential result as an "expectation" in the outcome. This process teachable to CIS via cognitive resonance, via decision - making learning circle, to make CIS capable to support human strategic decision making [21]. However, the mentioned intuitivism and interpretable improvisation are originated by the carbon agent.

According to the above, there is no question yet regarding the statement of John Smith, Manager of Multimedia and Vision at IBM Research who mentioned related the creativity the following: "It's easy for AI to come up with something novel just randomly. But it's very hard to come up with something novel and unexpected and useful [14].

In the case of CIS architecture to be considered the level of complexity. Simple tasks do not need a complex solution, i.e. CIS. Building CIS with complex problem-solving capability may increase the architectural, programming and other CIS building - related challenges in an unrealistic manner. Aspects impacted by the previous problem are including related technics, time, expertise newly developed parts, financial and other resources and capabilities, where all of the elements are available and orchestrated in a well -functioned manner both on a holistic and functional level. Lack of the expected functionality determinates the holistic system approach negatively, therefore, one of the essential tools/assets in the orchestration the synergy supported by infocommunication.

5 Zachman Architecture & its Cognitive Elements

By Wang definition: "Cognitive Informatics (CI) is a transdisciplinary enquiry of cognitive and information sciences that investigates into the internal information processing mechanisms and processes of the brain and natural intelligence, and their engineering applications via an interdisciplinary approach" [30].

In the case of cognitive elements, the contextual insight derives from the model, hypothesis generation, and continuous learning through cognitive resonance via HCI (Human - Computer Interaction), then the human (carbon agent) indirectly modifies the model, generating enabling CIS to generate new hypotheses across the learning process. Therefore, the most significant features of CIS the ability of the HCI and the interaction generated resonance, that enables CIS to improve their cognitive level.

Wang defined a model to describe the context of systems within Cognitive Informatics. "The Information - Matter - Energy (IME) Model, building a bridge between the natural world (NW) where the physical, concrete world (PW) and the abstract or perceptive world (AW) connected to each other, where matter (M) and energy (E) model the NW meanwhile, information models the AW." [30].

In this definition, the abstract and perceptive world is within the realm of human minds that is the subject of Cognitive Informatics through applying the formal methods of information processing.

Based on the above-definition, the role of the CIS within Wang's model can be interpreted in three ways. On being aware that the content of an Information Systems that we consider as information consists of data and programs as a combined unit, therefore we consider the second learning cycle across HCI to be the basis of observation, due to the first circle did not necessarily impact nor the NW, AW and CIS. Interpretations:

1. CIS equivalent of AW
2. CIS wedged entity between NW and AW
3. CIS a separated entity, therefore out form NW and AW

Meanwhile, we examine the various extension of our two-dimension world considering CIS's rule and place in it, we try to identify and describe the changes, including the causes and the communication channel on which CIS capable impacting the two-dimension related features.

1. CIS equivalent of AW: in this case, we consider CIS as a mathematical description of AW, therefore CIS equivalent of AW. In the second learning cycle, HCI generated resonance might increase AW/CIS cognitive capability as improve NW cognitive level too. The infocommunication channel is flexible it coincides with the path of energy and information flow between NW and AW (Fig. 1).

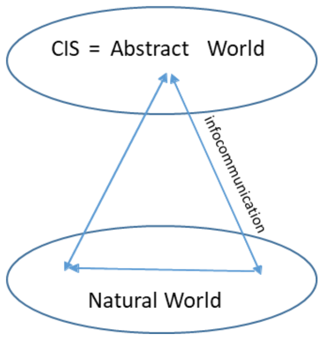

Figure 1
CIS equivalent of Abstract World

2. CIS *wedged entity between NW and AW:* In case we wedge CIS between NW and AW, meanwhile utilizing energy and matter across HCI as an input for the abstract world (AW) via the cognitive resonance as output for the natural world (NW) may transforms and extend the matter and increase the energy- related. The learning process may increase the physical world (NW) as human brain cognitive improvement. The improved (NW) capability ensure improved input for (AW), therefore it is improving too. The circle is repetitive, cognition improving both layers. Communication channel partly coincides with the path of energy and information flow (Fig. 2).

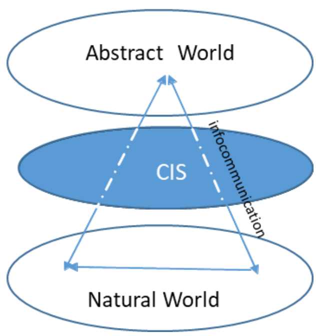

Figure 2
CIS wedged between Abstract and Natural World

3. CIS a separated entity, therefore out form NW and AW: In this case, each imputation of the NW increases the input of the AW, allowing inputs from the AW to the natural world to increase the expanse of the NW, which may be the other way around. Similarly, if we consider the cognitive system as a tool and include all a quasi-third dimension where our two-dimensional world gives and receives input through infocommunication, then the two entities grow in a parallel way, leading to an increase in cognitive abilities and knowledge. The

communication channel is separated from the channels between NW and AW, however, indirectly impacting the information and energy flow via infocommunication (Fig. 3).

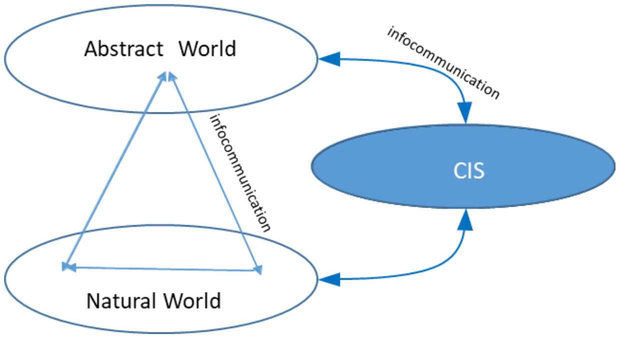

Figure 3
CIS is a separated entity, out form Abstract and Natural World

According to Wang [30] [29] there are 19 different CI factors in the relation of Software, however, the list might be extended with the below:

"*20. Flexible usage of infocommunication as a channel and methodology and tool utilizing the synergy generated across HCI as a cognitive resonance, between dimensions, independently of the location if CIS in the IME model.*"

Thus, the emphasis in the relation of the architecture on those components, that focus on learning via HCI, as the traditional machine learning methodologies and heuristic, statistic (regression, classification, etc.) approach resulting in the expected and reasonable output, but does not necessary provide unexpected but reasonable result by human across CIS computing.

That unexpected but reasonable output brings closer to mimic human brain capability, closer to the dreamed CIS, that seems to be as natural as possible considering humans as a natural being.

What are the expectations form the learning process?

According to MacLellan et al. "The features of HCI supporting naturalness, that related to the interaction is manifested in that (1) support the goals of users, (2) do what users expect, (3) lets users work the way they want, and (4) leverage users' experience to minimize training [19].

In case of during business analyses, if CIS is not capable of fulfilling the above-mentioned ones, the cognitive level is to be questioned. However, in the case of strategic management decision, the user expectation might create uncertainty related to the output, due to the user anticipation. The uncertainty that in relation to the exactly expected outcome, might trigger additional decision and additional learning cycle [21]. Strategic management decisions by humans consist of the general learning cycle i.e. observe, interpret, evaluate, decide that extended with the anticipation, a kind of "what-if " situation, that during HCI transformed to the knowledge of CIS. Repetitive strategic management decision making via HCI related to the same situation, in case the output doesn't meet with the expectation will trigger a new decision and learning cycle [21]. That is one of the sides, that can be interpreted based on the given situation as positive and as the negative side of the HCI. That is caused by the human anticipation build into the decision process. The risk and the reason what could be the explanation of the negative side, that due to human factors, if the output not acceptable, a human might trigger further decision circle - knowledge improvement for both sides - to get to the closest anticipated result [21]. That misleading exercise, not necessarily supports the organization in many cases, due to the time, effort, workload, in addition, might distort the reality of the output.

According to the above, the result of the cognitive resonance in the complex business environment, during use of cognitive systems, can provide a better result from many aspects, but still to be considered to find the proper technics/algorithm to be built into CIS, where infocommunication is used as a channel via HCI across cognitive resonance that supports better enterprises.

There are several methodologies of machine learning, however, HCI with cognitive resonance using info communication as a channel ensures the continuous improvement of the knowledge and cognitive level, impacting both the abstract and the natural world. Smooth stat solutions do not produce bloodless but acceptable results by not increasing the system's knowledge. Cognitive Infocommunication is an important element of the learning process because it provides the basis for cognitive resonance and plays a prominent role in the coordination of individual architectural details.

If we select an approach according to Information Theory, we should profoundly modify the models proposed by Wang [29]. As the CISs are components of the Digital Universe, i.e. CISs are composed of bits forming data that are embraced by formations to be represented by the carbon agent. The abstract world should be interpreted as the realm where the computing processing happens; the processes manipulate the formations automated way, primarily syntactically so that the data embedded into formations could be interpreted by carbon agents as information that owns semantic interpretation.

In this approach, each input coming out of the natural world increases the information content of the Digital Universe within the abstract world (Fig. 4). The information contained within an Information System having Data Collection Management Systems cannot increase through running queries and any data processing algorithms as the symbiosis of the program code and the data together defines the complexity of the content (see Benczúr et al. [5]).

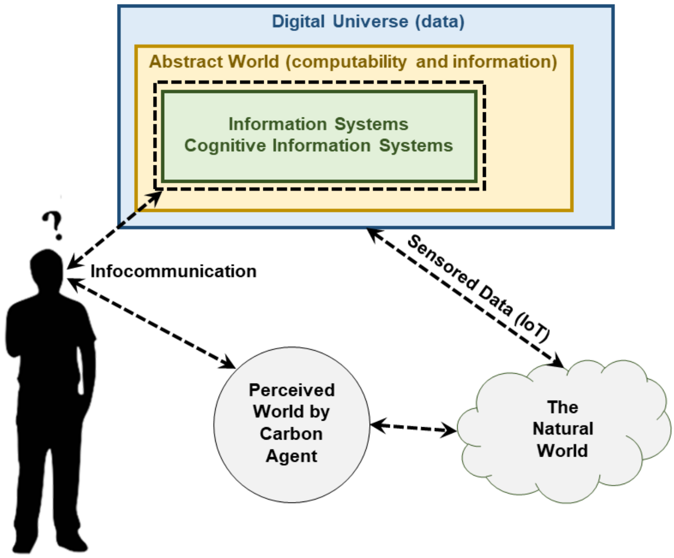

Figure 4
Cognitive Infocommunication in the context of Digital Universe and Cognitive Information Systems

Within a CIS, the set of data and algorithms constitute the information content, i.e. the computation may produce data encompassed in formations that were not still stored eventually in the system, but it does not augment the overall information content of the system. However, outputs from the abstract world within the Digital Universe to the natural world can enhance the knowledge of the carbon agent through perception and interpretation of the meaning of the communicated data. The carbon agent through cognitive activities creates actionable knowledge out of the information that was conveyed through formations. The abstract world consists of two parts, one part is the set of Information Systems that embodies the computational capabilities and the data stored in formations represented by bits, the other part is the set of Cognitive Information Systems that contain the most modern algorithms for data processing, visualization, and toolset to achieve a high level of cognitive resonance between the carbon agent and the silicon agent.

6 Cognitive Infocommunication in the relation of CIS & its architecture

According to Baranyi et al. [4], Cognitive Infocommunication is used to refer to devices and networks which can assign resources and functionalities in dynamic and intelligent ways. CIS is capable to elaborate information dynamically and intelligently, meanwhile, UBMSS missed those functionalities and dynamism [3].

That calls the attention of the importance of cognitive architecture with cognitive functions and appropriate cognitive level, the integration that allows the development of cognitive entities. There is a view that human cognitive capabilities and human intelligence are emergent properties that cannot be separated from the physical, biological, neurophysiological and higher-level bases of our mental existence [6]. However, the social and technological context of our interactions with other humans and ICT further influences the kinds of mental and physical work that we can perform [6], [12]. That is one fact that explains and highlights the importance of cognitive resonance, that enable human a CIS to improve their cognitive level. This is what only the real cognitive information system capable of, via inter Cognitive Communication and Cognitive Infocommunication. The architecture focuses on the representation of the information of both entities, within human and carbon agents.

Conclusions

The disciplined architecture approach can help in understanding the cognitive structure of information systems. The proposed application of architecture description methods allows a systematic depiction of a complex situation, where several interdisciplinary principles play roles, i.e. cognitive sciences, information systems analysis and design, formal architecture methods, and Data Science. The proposed method assists the development and construction of CISs at small and medium-sized enterprises that build up their systems from heterogeneous components exploiting open source software solutions, supports and utilize the synergies of cognitive sciences trough Cognitive Infocommunication improving the value of information, knowledge and learning.

The Enterprise Architecture helps reconcile the information exchange and infocommunication between the relevant components of a Cognitive Information Systems, namely, between automated Business Processes and actors/roles/business Entities. The architecture of the most recent Information Systems contains several components that compel serious cognitive efforts on the side of the carbon agent to keep in hand the overall processes and information exchange, to orchestrate the ensuing activities. The most modern Information Systems contain IoT elements (Internet of Things, actuators/sensors, etc.) and a huge amount of data that are harvested from IoT elements through Edge and Fog computing. The data are stored in an unstructured format in Data Lakes, in a structured format in Data Warehouses. To make it useful for the carbon agent, the interplaying of several methods and tools is required as visualization of the produced data, the data should be extracted and processes into meaningful format exploiting the available toolset of Data Science. The Cognitive Infocommunication fosters the bidirectional data stream to realize the cognitive resonance primarily on the side of the carbon agent. On the side of silicon agent, the cognitive resonance can be achieved through appropriate representation of the analogue and digital universe to provide an effective feedback for the carbon agent.

The success of an effective Cognitive Infocommunication in realizing cognitive resonance, will contribute to the improvement of the quality of Information Systems, this achievement will enhance the reliability and trust, in Information Systems.

Due to Cognitive Infocommunication integrative cognitive processes, where the capabilities of the human brain could be extended, not only through the equipment, but also within the interaction with the capabilities of any CIS. Cognitive Resonance improves the knowledge and the effectiveness of HCI making it more and more relevant, therefore, based on our view, it contributes significantly to part of Cognitive Infocommunication.

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