A New Approach for Cognitive Computing – from the humble beginnings to the dazzling future

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"The humble beginnings" will be discussed in a short overview of the main approaches that will claim they provide a generic methodology for developing machine intelligence of general settings. Special attention will be given to cognitive and semantic computing. A short state of the art will help to understand the present situation including IBM's Watson I, Watson II, Wolfram's Alpha and Google Brain.

In order to pave the way for "the dazzling future" a new approach is proposed, which provides a formal framework and tools to describe and analyse the data-information-knowledge transformation and processing at the different computation levels. Special attention will be devoted to the knowledge change and -management that results by learning. A special formalism will be provided in order to support the characterisation of different levels of computing from data processing until information and knowledge related processing.

This new, so called COgnitive Intelligence co-Operating System (COIOS) approach will help us bring the dazzling future closer allowing that it is just around. The COIOS approach has four foundation pillars: (i) unified theory of computing science, (ii) cognitive reasoning framework, (iii) hierarchic data science with data structuring and analysis, (iv) computational cognitive linguistics. The approaches developed in these four pillars can be integrated coherently into a unique, transdisciplinary metamethodology, where the achieved particular constituents will enhance each other into a qualitatively new cognitive computation theory and methodology. The methodological and technological platform will be the central production environment for the deployment of COIOS applications.

The first pillar provides a General Computing Theory which handles different levels of computation up to the situation oriented information and knowledge processing. Intelligence is an internal construct of this theory. This theory at the same time will be connected with the formal specification theory, which provides a high level declarative language schema for describing problem situations. The foundation of this theory is the unified mathematically well founded Computation Theory.

The second pillar provides a generic, unified technological and methodological framework for building semantics-driven and logic-based cognitive computing systems. The framework integrates cutting-edge research in formal semantics (at different levels) and non-classical logics, and supports understanding of interaction with the users, detecting and resolving actual uncertainties through complex information processing and cognitive reasoning, all founded on mining data acquired in real time. The so called cognitive reasoning framework (CRF) is developed on the basis of a logically well-founded integrated theory that permits the modelling of the cognitive activity and provides a constructive foundation of artificial cognizing agents.

The third pillar provides Hierarchic Data Science with data structuring and analysis. Hierarchic data science is a specific data science, which uses hierarchic analysis and structuring methods for realising the data-information-knowledge sequence processes. Appropriate handling of data, selection of appropriate data analysis method, and then, as a result, obtaining new information and finally, getting

new knowledge is one of the most important conditions for developing intelligent systems including efficient hybrid (human-computer) intelligent systems, too. The Hierarchic Data Science provides technology for data analysis, information and knowledge acquisition and at the same time it uses knowledge and appropriate cognitive methods to control and supervise the data-information-knowledge process. One of the main technological elements is the knowledge base for which a special form of knowledge organisation has been proposed, namely, the syndrome-symptom network technology together with the syndrome analysis method. The Hierarchic Data Science devotes special attention to two types of data sources: (i) to the world of regular events („Mediocristan") and to the world of extreme events („Extremistan"). Special approach is proposed to support cognizing in these worlds.

The fourth pillar provides a special approach to computational cognitive linguistics with the ontology capsule method and the corresponding cognitive semantic approach which were developed to support the management of natural language related situations. The proposed approach is a generalisation of Filmore's frame semantics and it is based on ontology technology and cognitive semantics. The semantic space of the proposed approach represents the interpretation of the input and it is structured by the capsules, which correspond to the situations. The proposed method allows not only the representation of the meaning of the individual elements of the input streams, but also to connect the interrelated elements of different streams, and to construct a representation of the situation which was their source.

The unique transdisciplinary metamethodology of the proposed approach will link the computing process theory with the Cognitive Reasoning Framework. It will define cognitive computing processes by the use of situations, infons and information. This extension will formalise the well-known constructions of situations and information[1,2]. Here Cognition Kernel will be one of the main constructs, which generalises (i) the information theory and the corresponding real reasoning inference system[3] on the one hand, and (ii) the modification theory and the corresponding modification calculi on the other hand. The results and methods of the Hierarchic Data Science will be embedded into the metamethodology, where special data handling calculus will be defined with appropriate heuristics. In the metamethodology a special mathematical toolset will be developed to support the network based data-information-knowledge sequence. Moreover, the metamethodology will contain the results and methods of integration of Cognitive Semantics and Cognitive Reasoning Framework for natural language handling and understanding. The metamethodology takes the basic positions of the second order cybernetics into account in order to provide constructive system development recommendations.

[1] Barwise, J. The Situations in Logic, CSLI, Stanford, 1989
[2] Devlin, K.: Logic and Information. Cambridge University Press, Cambridge (1991)
[3] Devlin, K., Modeling Real Reasoning in G. Sommaruga (Ed.): Formal Theories of Information, LNCS 5363 pp. 234–252, Springer, 2009.