Information **2012**, *3*, 16-20; doi:10.3390/info3010016

OPEN ACCESS

information

ISSN 2078-2489

www.mdpi.com/journal/information

Editorial

Introduction to the Special Issue on Information: Selected Papers from "FIS 2010 Beijing"

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Received: 15 December 2011 / Accepted: 30 December 2011 / Published: 4 January 2012

Abstract: During the last two decades, a systematic re-examination of the whole information science field has taken place around the FIS—Foundations of Information Science—initiative. With the occasion of its Fourth Conference in Beijing 2010, a group of selected contributors and leading practitioners of those fields have been invited to contribute to this Special Issue. What is the status of information science today? What is the relationship between information and the laws of nature? Is information merely "physical"? What is the difference between information and computation? Has the genomic revolution changed the contemporary views on information and life? And what about the nature of social information? Cogent answers to these questions and to quite many others are attempted in the contributions that follow.

Keywords: Foundations of Information Science; information theory; symmetry; entropy; hierarchy; information and computation; biological information; social information

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1. Beijing 2010: Broadening FIS Horizons

The IV International Conference on the Foundations of Information Science (FIS) was celebrated in Beijing, the capital of China, in August 2010. It was held along the same lines as the previous FIS conferences, but the venue included an important scientific community that was formerly absent. The relevant participation of Chinese information scientists and scholars, reflected both in the selected contributions of this Special Issue and in the Proceedings of the conference, may be considered as a milestone—and an important stimulus—in the advancement of the FIS endeavor.

It was in Chicago, 1991, that exchanges between Michael Conrad and Pedro Marijuán led the Foundations of Information Science initiative to surface as a feasible project. Following that initial dialogue, a small supporting network began to take form, thanks to the growing cooperation of colleagues from very different disciplines attracted by this venture: Koichiro Matsuno, Tom Stonier, Gordon Scarrott, Ray Paton, Peter Érdi, Johan De Vree, Peter Fleissner, Wolfgang Hofkirchner, Fernando Carvalho, *etc*. After some failed attempts in 1992-1993, the idea finally crystallized in a series of successful conferences (Madrid 1994, Vienna 1996, Paris 2005, and now Beijing 2010), producing a number of scholarly publications and a vast accumulation of electronic exchanges in a high-quality discussion list over all these years. See conference proceedings [1–3] and related websites [4,5].

From its very beginnings, the FIS initiative was 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 [1]. Thus, rather than the discussion of a single particularized concept, information science became the intellectual adventure of developing a *vertical* or transdisciplinary science connecting the different threads and scales of informational processes, which demanded both a unifying and a multi-perspective approach. As Michael Conrad [6] remarked, two rather antithetical methodologies had to be integrated: the hierarchical, level-centered 'horizontal' approach, and the percolation-network, multi-scale 'vertical' approach. Otherwise the adaptive, developmental and evolutionary capabilities around biological-informational systems could not be even approximately understood without considering the interplay of information phenomena at all scales.

Some of these foundational ideas on the peculiar synthesis, or better, knowledge recombination processes, necessary for establishing the new information science framework still reverberate in the current discussions and in the scientific literature. With the passage of time, it has become more and more clear that no solitary discipline, no specialized point of view, is capable of solving the numerous conundrums and conceptual puzzles around information. Above all, the advancement of information science 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 capable of cognitive tasks beyond the power of any single person.

This is not the place to attempt a balance on the state of the "emerging synthesis", but arguably the relative impact and success of FIS discussions has brought some new order and parsimony on the most poignant information topics, and the unifying attempts have gained a new breath [7]. However, the unending controversies over the concept of information in many different fields have not receded at all during the last two decades—perhaps the opposite is more true [8,9]. It is symptomatic that, almost from the start, the famous Shannonian information theory, the most accepted formal core for the whole information fields, was so badly misinterpreted in relation to order, entropy, uncertainty, knowledge, *etc*. In fact, two generations after the successful coinage of "information theory", are we able to define information? But is it definable at all? Maybe, like in the case of *time*, all we can do is to create some adequate standards in order to establish it (say, by *fiat*, amidst the networked processes of self-producing entities), and afterwards we become able to measure it, to encode and decode it, to transport via channels, to process, to amplify, to destroy it.

Anyhow, along the advancement of the foundations initiative, each one of the different FIS conferences has implied a new thematic focus and a new accent on the ongoing information discussions. In Beijing 2010, the incorporation of a significant number of Chinese scientists and

scholars has meant a new development in two main directions. On the one side, there was the connection of information discussions with the intelligence field, both at the formal level of "advanced artificial intelligence" and at the socially oriented approaches. In this aspect, the impact of the Eastern philosophical tradition was also quite visibly a point of reference. Within due proportions, during the exchanges on information science in Beijing 2010 a reminiscence of other historical encounters between the East and the West could be sensed (the monumental volumes of Joseph Needham [10], contain some of the best studies on the amazing bilateral flows of technology, culture, and science between West and East over world history). On the other side, at the Beijing 2010 conference a new international community of scientists and scholars for the advancement of information studies was advocated; for one of the central objectives of the meeting was the foundation of a multi-disciplinary union in information studies at the international level in which the multifaceted aspects of information (formal, physical, chemical, biological, cognitive, ethical, philosophical, and also the social and technological aspects) were integrated.

The shared interest for consolidating a meta-discipline for the study of information including the aforementioned aspects offered a sufficient basis to achieve a consensus and decide the specific constitution of the international society. It was agreed to call the new founded society *International Society for Information Studies (ISIS)*, specifically incorporating the domains of *science, society*, and *technology* within the scope of information studies. The new society has just been created legally in Vienna and will shortly start its public activities. The appearance and consolidation of the ISIS scholarly community of information scientists could be the most important outcome of the Beijing conference.

2. Special Issue Contributions

The contributions to this Special Issue have covered quite many different angles and topics of information science. Starting with the formally oriented approaches, there is the contribution of Robert E. Ulanowicz, which quantifies the *apophatic side* of information, pointing out from the Boltzmann's and Shannon's approaches how the "third law of thermodynamics" may open information to the idea of *absence*, leading to a more encompassing perception of reality and to a far more appropriate description of the behavior of living systems than conventional dynamics. In a highly original approach to the underlying *physics of information*, Koichiro Matsuno associates it with the flow of time, both in the sense of the molecular update of generative processes and in the subject's verbal descriptions. The unfathomable depth of information is linked with the capacity to receive the immense flow of messengers in their own kinds addressed towards those having the capacity of receiving them, emphasizing the importance of the receptor so that finally information is being embodied by it. Yi-Xin Zhong aims at the general definition of information—a unity has to be introduced so that at the same time that coheres the present diversity maintains the possibility of further definitions in different realms. A system approach can do that, incorporating also the link with knowledge and intelligence, and finally arriving to the information eco-system concept.

In another approach to information, understood as a bridge between mind and brain, Marcin J. Schroeder unifies two of the main manifestations of information implicitly present in literature, the selective and the structural. Formulated in this way, together with the concept of integration, one can use information to explain the unity of conscious experience as well as other aspects of human sentience. Stanley N. Salthe deals with naturalizing the information concept by

considering a subsumptive hierarchy derived from the different levels of organization in nature; the resulting hierarchy, with the thermodynamics subsuming information theory, and that in turn subsuming semiotics, amounts to a naturalizing of the information concept. For Gordana Dodig-Crnkovic, information dynamics is not only found in human communication and computational machinery but also in the entire nature; thus the computational approaches currently modeled by the Turing machine have to be put in the wider context of "the second generation models of computation", as epitomized by natural computation, which provides the most general representation of information dynamics. Starting from symmetry principles and natural laws, György Darvas argues about minimizing the quantity of information we need to communicate about a system; but we must keep in mind the conventions we have to learn about the abbreviating mechanism of those principles, laws and mathematical descriptions.

On the formal unification side, proposing a new information theory, Wolfgang Hofkirchner discusses the basic understanding of information in Information Science, the Shannon's type of "information" at which numerous criticisms have been leveled, and argues that the main task of an as-yet-to-be-developed Science of Information should be to study the feasibility of, and to advance, approaches toward a more general Unified Theory of Information (UTI) and toward a common concept of information. For Mark Burgin it is possible to consider not only knowledge but also beliefs as basic components of cognitive infological systems and consider the information that acts on such systems as epistemic information. Thereafter, by means of algebraic construction of M-spaces, one can represent the information dynamics by information operators acting in knowledge spaces. As a synthetic approach, this general theory of information provides efficient means for theoretical unification of the whole field. Julio Michael Stern focuses on the role of entropy in Bayesian statistics as a tool for detection, recognition and validation of eigen-solutions. Special attention is paid to some objections to the concepts of probability, statistic and randomization posed by George Spencer-Brown, who had such a great influence in radical constructivism. Jose M. Díaz Nafría and Rainer E. Zimmermann continue with the theoretical unification line by working out the interrelationship between information and meaning. They treat matter, energy and information as three different categorial aspects of one and the same underline primordial structure. They thus demonstrate the presently developing convergence of physics, biology, and computer science (as well as the various theories of information) eventually leading up to the further of unification of Hofkirchner's UTI and biosemiotics.

Zong-Rong Li, Xiao Zhou and Ai-Jing Tian discuss new interdisciplinary ideas about information science and the Humanities; they introduce the basic methodological concepts of humanistic informatics and propose a new articulation for the subject field based on the historical view of R.G. Collingwood through the prism of "informationalism". Raquel del Moral, Mónica González, Jorge Navarro and Pedro C. Marijuán introduce a bioinformational paradigm—based on the informational dynamics of the living cell—and present the crucial evolutionary phenomenon of "knowledge recombination" as a general strategy of real cognizing subjects (cells, nervous systems, societies) in order to build and expand their repertoires of adaptive knowledge. This genomic-inspired perspective to distributed cognition may also be applied to culture and science, as "culturomics" and "scientomics", respectively. Finally, in the contribution of Xue-Shan Yan the historical development of information science and its main currents both in the West and the East scenarios are analyzed; after careful consideration of the present unification attempts, the author makes some strategic proposals

and suggestions on how the international community of information scientists and scholars should advance the new science.

Acknowledgements

We would like to thank all the participants of this Special Issue for their very significant contributions, and the Journal editor, Mark Burgin, as well as the editorial office of *Information* for their patience and careful production of this special number. We also want to acknowledge the positive support and cooperation of Shu-Kun Lin, responsible person of *MDPI* (Multidisciplinary Digital Publishing Institute) and *Sciforum*, who kindly provided web support for Beijing 2010. The Journal *Triple C* is kindly acknowledged for their permission to some of the authors to rewrite contributions presented in the Proceedings of the conference; other invited contributors to this special issue could not attend the FIS venue and have presented here their original works. Finally, the Chinese organizers of FIS 2010, Ou-Yang Kan and Zong-Rong Li, as well as Hua-Can He and Yi-Xin Zhong, and many other Chinese colleagues and time-honored FIS members of the International Program Committee deserve all of them our heartfelt gratitude. The fourth International Conference on the Foundations of Information Science took place as a part of the 2010 Multi-Conference on Advanced Intelligence (MCAI), Beijing 2010, chaired by Yi-Xin Zhong. We must acknowledge and thank his friendly hospitality.

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