

World Scientific Series in Information Studies – Vol. 10

PHILOSOPHY AND METHODOLOGY OF INFORMATION

The Study of Information in a Transdisciplinary Perspective

The book gives up-to-date, multi-aspect exposition of the philosophy and methodology of information, and related areas within the nascent field of the study of information. It presents the most recent achievements, ideas and opinions of leading researchers in this domain, as well as from physicists, biologists and social scientists. Collaboration of researchers from different areas and fields opens new perspectives for the understanding of information essential in the innovative development of science, technology and society.

The book is meant for readers conducting research into any aspect of information, information society and information technology. The ideas presented give new insights for those who develop or implement scientific, technological or social applications. They are especially for those who are participating in setting the goals for science in general and sciences of information in particular.

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PHILOSOPHY AND METHODOLOGY
OF INFORMATION

Dodig-Crnkovic
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Vol. 10



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The Study of Information in
a Transdisciplinary Perspective

Editors

Gordana Dodig-Crnkovic
Mark Burgin

 **World Scientific**

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Introduction: The Study of Information in the Context of Knowledge Ecology

Gordana Dodig-Crnković and Mark Burgin

1. The Study of Information (SOI) and Related Research Fields

Philosophy and Methodology of Information is the first volume, which together with *Theoretical Information Studies* comprises the two-volume edition with the aim of laying out the foundation of the emerging research field of *the Study of Information* (SOI). It is based on the summit of the International Society for *the Study of Information* held in Gothenburg in 2017 (<http://is4si-2017.org>). This volume contains a selection of the best philosophical and methodological contributions from the Gothenburg summit, together with number of invited contributions of leading contemporary researchers in the field of *the Study of Information*. It is divided into four parts: Philosophy of Information, Methodology of Information, Philosophy of *the Study of Information* and Methodology of *the Study of Information*.

This volume presents works that establish philosophical and methodological aspects of a new interdisciplinary/transdisciplinary field of study, with new ways of knowing and models of explanation, based on data-information-knowledge ecology (Capurro, 1990; Zhong, 2011; 2017; Burgin, 2017a; Burgin and Zhong, 2018), and transdisciplinarity (Burgin and Hofkirchner, 2017). It provides perspectives on information as a phenomenon which connects together, and enables new non-reductive unifications of phenomena otherwise studied in isolation within domains of particular sciences, humanities, technologies and arts, as well as other fields dedicated to the study of information. Currently, specialized academic

fields divide human knowledge and experience into silos isolated from each other. Based on the research results of the domain-knowledge, *the Study of Information* seeks a new, networked approach to enable an inclusive view, from which future research projects transcending disciplinary boundaries will derive, based on understanding of information structures and processes underlying particular domains. *The study of information* involves a recursive process of analysis and synthesis through continuous learning — about the natural as well as synthetic/created/cultural worlds, and about their actors — living beings and artificial agents. The methodology varies between multidisciplinary and transdisciplinary methods (Burgin and Hofkirchner, 2017), ecological approach (Capurro, 1990; Zhong, 2011; 2017; Burgin, 2017a; Burgin and Zhong, 2018) and networking techniques (Díaz Nafría, Burgin and Rodriguez-Bravo in this volume) where different parts of the whole retain autonomy in constant communication with other actors/agents in the network of networks of knowledge sharing agents.

Information is a topic addressed in a variety of educational and research fields: Information Science, Library Science, Library and Information science (LIS), Information Studies, Study of Information, Informatics, Bioinformatics, Foundations of Information Science (FIS), Information Philosophy (IP) and more. Almost forty years ago, Machlup and Mansfield identified 39 information-based disciplines (Machlup and Mansfield, 1982), while in 2011 Yan listed 172 information disciplines (Yan, 2011). When it comes to sciences of information, Yan distinguishes three historically developed basic domains: Computer and Information Science, Library and Information Science and Telecommunications and Information Science.

The historical development of new information-based fields followed the development of new information and communication technologies as well as new insights brought about in information processing, information storage and communication. An important contribution to the understanding of information and its mechanisms comes from its applications in natural sciences (physics, chemistry and biology), cognitive sciences, neuroscience, social sciences and especially, models of social and individual cognition (cf., for example, (Von Baeyer, 2003; Frieden, 2004; Seife, 2006; Vedral, 2010)).

Each of the new and more detailed insights into the role of information in the control of living organisms from the level of molecular processes and up, through subsequent emergent levels of organization, points towards fundamentality of information (Deacon, 2011) and computation as the dynamics of information (Dodig-Crnkovic, 2011; 2017).

The Study of Information (SOI) as an emerging contemporary foundational framework is dedicated to building a broader, inter/cross/transdisciplinary approach to information in its different forms based on ecological view of information and knowledge (Zhong, 2011; 2017; Burgin, 2017a; Burgin and Zhong, 2018). It emphasizes the dynamic connection between the parts (particular knowledge domains) and the whole and their mutual interactions, as well as their context dependence, where context is given by the awareness of the presence of the whole ecology of information entities — structures and processes in different domains and on different levels of abstraction. Zhong (2017) argues that information ecology cannot be adequately modeled by “divide and conquer” method in which the system is partitioned into independent parts. Instead, complex nature of the ecological system must be recognized and the essential role of interaction between its parts. Complexity of information is addressed in the works of Burgin and Calude (2016 and Schroeder 2016).

The SOI differs in its scope and methods from all other currently existing approaches to information. For instance, when it comes to LIS, its unique concern is described as: *Humans becoming informed (constructing meaning) via intermediation between inquirers and instrumented records. No other field has this as its concern* (Konrad, 2007, p. 660).

The difference between SOI and LIS is that main interest of SOI is not in the *human use* of information (such as information search and retrieval, library management, knowledge management, knowledge organization, etc.) but in the structures and processes of information in all its manifestations including the human use of information.

Scientific approaches to information are grouped under the umbrella term of *Information Sciences*. With respect to the domain, Information Sciences can be divided in the Technical, Natural, Cognitive and Social Information Sciences.

The term “Theoretical Information Science” is used for different fields — from theoretical Computer Science to theoretical aspects of Information Science (comprising “IS” in “LIS”). Theoretical information science sometimes refers to the *development of information technologies* including computing, programming and telecommunication systems addressing modeling and analysis of information processing systems. Modeling typically involves formal-logic and algorithmic models of computing systems, analysis and verification; data transmitting protocols in information networks, algorithms and programs for information processing, etc.

Informatics is the term used in Europe as synonymous to both Computing and Computer Science, where Computer Science is often dominated by the study of algorithms and “automated abstraction”. Interesting to note this connection between information as a structure and computing as a process which often come together (Dodig-Crnkovic and Burgin, 2011).

Development of *Information Philosophy/Philosophy of Information* can be traced back to works of Floridi (2002) who describes its aims as 1. *the critical investigation of the conceptual nature and basic principles of information, including its dynamics, utilization and sciences* and 2. *the elaboration and application of information-theoretic and computational methodologies to philosophical problems*. Along similar lines, it is possible to find works of other philosophers of information, such as Adriaans and van Benthem (2008) and Adriaans (2018). At the same time, Wu (2016) points to the interaction and convergence between the philosophy of information and science of information, while Wu and Brenner (2017) propose viewing *Philosophy of Information* as an informational meta-philosophy of science. In addition, Herold (2001) elaborates the relationships between *Librarianship* and the *Philosophy of Information*.

In sum, *Philosophy of Information* is a dynamic and diverse research field (Adriaans and van Benthem, 2008). One may ask why we don’t simply label this book “Philosophy of Information” instead of insisting on it being a part of the emerging field of *The Study of Information*. In the first place, because we want to establish explicit knowledge ecology of information studies in which *Philosophy of Information* informs all other actors in the network of networks as well as being informed through mutual interactions. We are elucidating these connections.

Besides, we make a distinction between philosophy of information and philosophy of information studies treating methodology of information and logic of information as separate fields.

We also want to emphasize essential dependence of *The Study of Information* in general, and philosophy of information, in particular, on *methodology of information* and *logic of information* as essential parts of the Study of Information. Examples of work offering new logical perspectives are Brenner (2006) exploring transconsistent logic for model-based reasoning, Allo (2007) studying necessity of logical pluralism, and Brenner (2008) addressing the logic of transdisciplinarity. While van Benthem and van Rooij (2003) proposed the way of “connecting the different faces of information, van Benthem (2010) connects logical dynamics of information and interaction. In addition to connecting (in both ways) *Philosophy of*

information with sciences and technology, we also make connections with its methodological and logical foundations that are in a continuous evolution.

We can see the development of the Study of Information within the IS4SI community as grounded in the activities of the Foundations of Information network, <http://fis.sciforum.net/about-fis>, led by Marijuán (2013); UTI (Unified Theory of Information) network led by Hofkirchner (1999, 2017) and Glossarium Bitri network and information glossary project led by José María Díaz Nafría (Nafría *et al.*, 2016). All three networks focus on theory of information and its different aspects.

In the publication area, the work of Mark Burgin as the Editor of the World Scientific book series on Information Studies <https://bit.ly/2Q7Pt3W> is an important contribution to the progress of the research field. Burgin has also extensively published on data, information and knowledge (Burgin, 2010a, 2010b, 2011, 2016, 2017b). Other members of the IS4SI community have also essentially contributed to SOI: Rafael Capurro with the conceptual analysis of the concept of information (Capurro, 2009) and the study of the social aspects of its utilization (Capurro, 1990); Yixin Zhong with the development of information ecology as a methodological approach to the study of information (Zhong, 2011, 2017; Burgin and Zhong, 2018); and Gordana Dodig-Crnkovic with the study of dynamics of information in the form of morphological computation by cognizing agents (Dodig-Crnkovic, 2008, 2011, 2016, 2017). Deacon (2011) in his book *Incomplete Nature: How Mind Emerged from Matter*, addresses information as appearing in hierarchy of dynamic processes in nature — homeodynamics, morphodynamics and teleodynamics connecting biosemiotics, origins of life and philosophy of mind.

2. Exploring Philosophy and Methodology of Information on Different Levels

In this volume, philosophy and methodology of information are explored through their various facets, with information as the fundamental concept that is changing philosophy and methodology of research and knowledge generation in general, and of the study of information, in particular, while philosophical and methodological insights affect our understanding of the information as a fundamental phenomenon.

According to Howell (2013, p. 32), research (on a given topic) establishes the relationship through succession between philosophy (ontology and epistemology), theory, methodology and methods.

Philosophy of Information: *Philosophy of Information*, as a part of philosophy, includes ontology, epistemology, ethics and aesthetics of information.

The basic questions of the *ontology* of information being: how information exists, what information is; how information functions, how it is generated, communicated and processed; relations of information to other fundamental phenomena and in particular, relations between data, knowledge and information. Existence of information, its processes and structures are derived from sciences, which provide our best present day knowledge about the world (Zuse 1969; Wheeler 1990; Schmidhuber 1997; Wolfram, 2002).

The basic questions of *epistemology* of information are: how knowledge about information is obtained; how knowledge about information is justified, the role of information in cognition and knowledge generation. With regard to *epistemology*, information is used both as an object of study and as a means of study. Again even in this respect, fundamental insights are made by connecting knowledge of diverse areas (Dodig-Crnkovic, 2017).

Aesthetics of information is a vivid research field, dedicated often to visual arts and music and exemplified in the works of Schmidhuber (1997), Adriaans (2008), Kang Zhang *et al.* (2012) and McLean and Dean (2018).

Methodology of Information: (*The methodology is defined as the research strategy that outlines the way one goes about undertaking a research project*, (Howell, 2013, p. ix) whereas methods identify means/tools of knowledge generation. In this context, methodology of information studies methods of information observation, measurement, evaluation and utilization such as information production, acquisition, processing, preservation, protection, restoration, comprehension and communication.

Philosophy of the Study of Information: It includes ontology, epistemology, ethics and aesthetics of the study of information. It explores the place of the study of information in knowledge production, its interaction with other scientific and technical/applied/practical disciplines, the goals of the study of information and how knowledge about information and information processes is obtained.

Methodology of the Study of Information: The methodology of the study of information is the research strategy that outlines the way one goes about undertaking research projects in the field of the study of information, while methods of the study of information identify means of knowledge generation within the field of the study of information. This presents the

level of meta-theorizing with respect to the basic level of studies of the information phenomenon. Methodology of the Study of Information is concerned with problems such as how different fields of study of information relate, how to organize studies of information and how to utilize knowledge obtained in the studies of information.

3. Contributions to the Book

The first part of the book is dedicated to the *Philosophy of Information*, with chapters encompassing a broad spectrum of ontological and epistemological issues of information. Peter Boltuc sets the stage by investigating the fundamental philosophical question of differences between subject and object in the context of the Philosophy of Information. Joseph Brenner addresses information in science, logic and philosophy through the vision of Stephane Lupasco.

Terrence Deacon focuses on relativity of information. It is an important cognitive challenge in general and scientific problem, in particular, because in many situations it is hard to differentiate between information and noise. Indeed, relativity of information is affirmed in the first Ontological Principle of the general theory of information, which, in particular, states that empirically, it is possible to speak only about *information for a system* and not information in general (Burgin, 2010; 2017b). Analyzing the real situation in the history of science, Deacon's work gives a brilliant example of this principle.

En Wang investigates the concept of "*Objective Non-Reality*" connecting it to the phenomenon of information in the context of Information Philosophy. The concept of non-reality, non-being and nothingness has been discussed both in Western and Eastern philosophy for millennia. In Western philosophy, it goes back to the *Sophist* of Plato (1961) and to *Physics* of Aristotle (1984). In Eastern philosophy, this concept appears in Tao Te Ching by Lao Tse (cf. (Kirkland, 2004)):

... *advantage comes from what is;*
usefulness comes from what is not.

Philosophers introduced different types and modes of non-being. For instance, Marius Victorinus splits non-being into four categories: negation, the nature of the other (*secundum naturam alterius*), as potential being, and as transcendent non-being (Victorinus, 1960; Piemonte, 1986). Eriugena defines five modes of being and non-being admitting that it is possible to

find more by crafty reasoning (Moran, 1989). Contemporary approach goes even further being able to differentiate between non-reality, non-being or nothingness (Burgin, 2012).

Kun Wu and Wang Ping argue for the Philosophy of Information as a radical changing force in philosophy as a whole. Indeed, all cognition, including philosophical cognition, is based on information acquisition, procession and comprehension.

Rossella Lupacchini's contribution presents a broad picture of reality starting with Plato's *Allegory of the Cave* and going through theories of painting to quantum interference to Leibniz's monads to photons and light to matter to quantum computation, qubits and information. In her exposition, Lupacchini contrasts light and shadow in her qualitative characterization of the phenomenon of information.

Gustavo Saldanha, Vinícius Souza de Menezes and Rodrigo Bozzetti explore informational ontogenesis and philosophical-symbolic dilemmas in the context of ethical applications of social epistemology.

The second part of the book, *Methodology of Information*, treats the research strategies involving study of information.

Mark Burgin explores relations between information-based knowledge discovery and the processes of invention in the realm of mathematical creativity, based on the information core of both processes and the global structuration of the world in the form of the Existential Triad. The goal is to provide an explanation, argumentation and empirical evidence validating the claim about existence of both processes in mathematics.

Rodolfo Fiorini's contribution presents evolutive information as an idea whose specific and contingent understanding involves interdisciplinary, trans-disciplinary, cultural and ontological multi-perspectives in the context of Cybersemiotics (Brier, 2008).

Lorenzo Magnani describes the connection between information, computation and cognition explicating the evolutionary emergence of information, meaning and cognition in humans, as the outcome of dynamic co-evolutionary interactions between brain/mind processes, body and environment.

Marcin Schroeder's contribution provides scientifically motivated mathematical foundation for a dual role of information as "a difference that makes a difference" and as "identification of a variety" based on the ideas of invariance and symmetry. In such a way, Schroeder explicates two types of information, which are important special cases of the general concept of information which is described in the general theory of information.

It is possible to obtain these two types by a relevant choice of the infological systems (Burgin, 2010). This gives additional evidence that the general theory of information encompasses all kinds and types of information.

At the same time, it is necessary to accentuate that existence of the general theory of information does not decrease the role and importance of various special information theories, such as Marcin Schroeder's information theory (Schroeder, 2015) or Krassimir Markov's information theory (Markov *et al.*, 2006). We can see how theories of groups, of rings and of fields occupy principal places in mathematics although all of them are special subtheories of the theory of universal algebras (Cohn, 1965).

Wang Peizhuang proposes a unified mechanism for the transformation of information into knowledge in artificial intelligence, synthesizing in such a way characteristics of structuralism, functionalism and behaviorism.

Rainer Zimmermann and Xiaomeng Zhang study the grounds for the concepts, formal or hermeneutic, in the relationship of philosophy and the sciences, as well as in relation to the arts.

The third part of the book is dedicated to the *Philosophy of the Study of Information*.

In the opening chapter, Jordi Vallverdú explores the situated nature of information ontologies. Wang Zhensong argues for necessity of integration of information science with information philosophy to form a unified knowledge field.

Liu Jun demonstrates modernity of Confucianism from the perspective of the philosophy of information. In particular, we know that Confucius thoroughly considered knowledge and its sources paying much attention to names as carriers (bearers) of information about reality (Confucius, 1979):

If names be not correct, language is not in accordance with the truth of things. If language be not in accordance with the truth of things, affairs cannot be carried on to success.

At the same time, names play more and more important roles in the contemporary technology in general and computer networks such as the Internet, in particular (cf., for example, (Shoch, 1978; Ballintijn *et al.*, 2001; Burgin and Tandon, 2006)).

The fourth (last) part of the book is devoted to *Methodology of the Study of Information*.

Søren Brier's contribution presents an argument for using the cybersemiotics approach for building a foundation of the transdisciplinary study of information.

Pedro Marijuán offers Ten Principles of Information Science as methodological principles of its development. These principles are oriented towards life sciences and are aimed at a transition from a fragmented landscape of information fields to a consistent disciplinary body of the unified “information science,” which is critically important because blinded by the contemporary promises of global big data researchers barely recognize the perils and pitfalls of information contained in these data and its acquisition.

José María Díaz Nafria, Mark Burgin and Blanca Rodríguez-Bravo dedicate their chapter to the study of conceptual representation of knowledge. They develop a mathematical model of conceptual knowledge representation and suggest knowledge integration based on this model, network technology and formation of a hypertext of conceptual knowledge.

Huacan He, Y. Q. Zhou and Z. C. Chen propose Universal Logics for intelligent information processing required by information ecology. Ouyang Kang uses Information Ecology to explore Cognitive Justice through its Core Values and Methodological Principles. The concluding chapter, written by Yixin Zhong, argues for information ecology as a fundamental methodological approach of the Study of Information.

In sum, this book gives an up-to-date multi-aspect exposition of contemporary studies in Philosophy and Methodology as being addressed in the field of the Study of Information. Collaboration of researchers from different research fields opens new perspectives for innovative developments in a variety of areas of sciences, humanities and technologies with applications. The book is aimed at readers who conduct research into fundamental aspects of information, information society and information technology. It opens new perspectives for those who develop or implement scientific, technological or social applications, and especially for those who are participating in setting the goals and policies for science in general, and sciences of information in particular.

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