Interdisciplinary elucidation of concepts, metaphors, theories and problems concerning INFORMATION

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glosariumBITri

Coordinators:

José María DÍAZ NAFRÍA, Mario PÉREZ-MONTORO GUTIÉRREZ,

Francisco SALTO ALEMANY

Secretaría de
Educación Superior,
Ciencia y Tecnología

glossariumBITri

Interdisciplinary elucidation of concepts, metaphors, theories and problems concerning INFORMATION

Elucidación interdisciplinar de conceptos, metáforas, teorías y problemas en torno a la INFORMACIÓN

The glossariumBITri, planned as a central activity for the interdisciplinary study of information, developed by BITrum group in cooperation with the University of Santa Elena (Ecuador), essentially aims at serving as a tool for the clarification of concepts, theories and problems concerning information. Intending to embrace the most relevant points of view with respect to information, it is interdisciplinarily developed by a board of experts coming from a wide variety of scientific fields. The glossariumBITri kindly invites the scientific community to make contributions of any kind aimed at clarifying in the field of information studies.

El glossariumBITri, concebido como uno de los ejes para el estudio interdisciplinar de la información desarrollado por el grupo BITrum en cooperación con la Universidad Estatal Península de Santa Elena, pretende servir de instrumento para el esclarecimiento conceptual, teórico y de problemas en torno a la información. Tratando de abarcar el máximo de puntos de vista relevantes respecto a la información, su desarrollo es interdisciplinar contando con la participación de expertos de reconocido prestigio en muy diversas áreas científicas. El glossariumBITri invita cordialmente al conjunto de la comunidad científica a realizar contribuciones que busquen el esclarecimiento en el ámbito de los estudios informacionales.

Editorial Coordination | Coordinación

José María Díaz Nafría, University of Santa Elena, Ecuador; Munich University of Applied Sciences, Germany
Mario Pérez-Montoro Gutiérrez, University of Barcelona, Spain
Francisco Salto Alemany, University of León, Spain

Correction team | Equipo de corrección

Basil Al Hadithi, Technical University of Madrid, Spain
Rosa Macarro, University of Extremadura, Spain
Mercedes Osorio, I.E.S. Ramiro de Maeztu, Madrid, Spain
Anthony Hoffmann, University of Wisconsin Milwaukee, USA

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Mehrad Golkhosravi (University of Barcelona, Spain)

Interactive-gB | gB-interactivo

http://glossarium.bitrum.unileon.es

Contacto | Contact

bitrum@unileon.es

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Introduction to the first edition

> *"Concepts lead us to make investigations; are the expression of our interest, and direct our interest."*
>
> Ludwig WITGENSTEIN, *Philosophise Untersuchungen*

> *"Information is a difference which makes a difference."*
>
> Gregory BATESON, *Steps to an ecology of mind*

Terms included in this glossary recap some of the main concepts, theories, problems and metaphors concerning INFORMATION in all spheres of knowledge. This is the first edition of an ambitious enterprise covering at its completion all relevant notions relating to INFORMATION in any scientific context. As such, this **glossariumBITri** is part of the broader project **BITrum**, which is committed to the mutual understanding of all disciplines devoted to information across fields of knowledge and practice.

Ramon Llull´s tree of science

This glossary pretends to make explicit the conflicts and agreements among use and meaning of terms related to information phenomena. Information is approached from opposing paradigms and also from competing and cooperating disciplines. Both in science and in ordinary life, conceptual, ethical, technical and societal problems regard information in an essential way. This glossary does not endorse or presuppose any paradigm or any theory, but rather locates into a public, explicit and commonly understandable space some of the crucial assumptions dividing informational concepts, theories, problems and metaphors. Moreover, we purport to embrace all distinct paradigms with a critical and comprehensive attitude.

The glossary is the result of an original methodology, which places any entrance under the responsibility of its editor. Authors possibly distinct from the editor contribute to different articles with texts, comments or discussions. Since authors come from many distinct fields of knowledge, each article should reflect many perspectival but rigorous approaches.

The glossary is an open work: the number and contents of all its entrances are updated and submitted to revision by editors and authors. For this reason, this first edition is only a first step in the active development of this collaborative methodology. Any interested reader wishing to contribute, may contact the general editors.
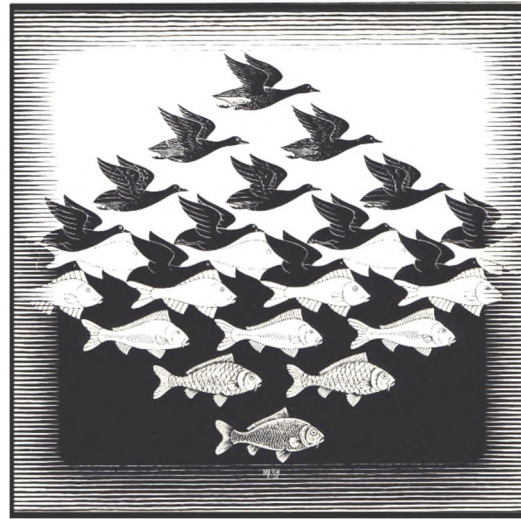
This glossary is most indebted to the enthusiasm and work of José María Díaz Nafría. The editorial team, authors and correctors thank the Universidad de León and Caja España for their support to this initiative.

Francisco Salto Alemany

León (Spain), November 2010

Introduction to the present edition

"There have always been thinkers to believe that the fields of human knowledge betrays a fundamental unity. In modern times people ready to discuss this unity have come under grave suspicion. Surely, the critics argue, no man is so presumptuous as to imagine that he can comprehend more than a tiny fraction of the scope of contemporary science. [...] And yet there are still men prepared to pursue the path of unity, and to discuss problems in an inter-disciplinary fashion: that is, without regard to the specialised viewpoint of any one branch of science."

Stafford BEER (Cybernetics and Management, 1959)

Four years after appearing the first book edition of the *glossariumBITri* (gB), it faces now a new phase of development, in which this new book version represents a milestone. The first development phase, 2008-2010, was clearly marked by an intensive cooperative work to stand up the clarification enterprise in which the gB is embarked on. Right after such phase, the gB was nurtured through valuable inputs covering essential aspects as semiotics, computation, complexity, etc., by distinguished researchers who have certainly enriched not only this book but the working team who is now before a more ambitious horizon.

Besides some improvements in previous articles, the most important additions to the previous edition, incorporated herewith, corresponds to the articles developed in the areas of algorithmic theory, complexity theory, General Theory of Information and Cybersemiotics that we heartily thank to the cherished contributions of Mark Burgin and Søren Brier. Nevertheless, the flesh of the glossariumBITri has been enriched as well through entries, which do not show up in this book since they are still under review or discussion, but they surely will in the next edition. They are, of course, available in the interactive-gB. For this dressing up the naked bones of the gB, we warmly thank the contributions provided by Balu Athreya, Igor Gurevich, Basil Al-Hadithi, Agustín Jiménez, Alexis Rocha, Daniel Gómez, Carlos Sarmiento. The incorporation of some of the topics which are now available, either in this book or in the interactive-gB was simply a must (as algorithmic information), others represent an initiation into fields we have to deepen (as information in biological sciences). But nonetheless, if we take into account all the concepts we have not weaved yet into the network of clarified concepts, metaphors, theories and problems, then we can clearly state that we are at the very beginning. By simply looking into the interactive-gB's list of open voices, which are still empty, or into the number of voice proposals we have not open yet, it is easy to conclude we are before a large and of course open enterprise.

One could argue the situation is not as different as before; then why are we saying we are now facing a different horizon? This is entangled with the current rearrangement of BITrum's activities. On the one hand, we have more coherently organised the different endeavours we have been pushing along the years in order to bring about a more effective cooperation among BITrum's members and other stakeholders; on the other hand, gB has been structured in three branches: a) interactive-gB, b) gB-journal, and c) book editions. Through a rationalisation of efforts, this new gB landscape obviously offers a multiplied effect regarding impact, dissemination and educational applications. To cope with the new challenges gB team has been enlarged and put besides other three BITrum's operating units: (i) *domusBITae* devoted to the deployment of telematic tools for the facilitation of the distributed and interdisciplinary community of researchers and educators cooperating in the development of information studies. (ii) *PRIMER*, oriented to the promotion, development and underpinning of interdisciplinary studies; and (iii) a *Research Unit*, integrated by the teams working on specific scientific projects.

Through this reorganisation, gB offers a more coherent platform for the clarification and theoretical enterprise BITrum has been aiming at since its beginnings, linking its development to BITrum's information environment (dB), educational activities (PRIMER) and research projects. Such interplay – albeit the autonomy of the respective operations – represents a nurturing flow that will provide a new life to the clarification goals of the gB in connection to real problems and the education of scientist to tackle them.

The activities deployed since 2014 under support of Ecuadorian institutions, in both research and education, constitute a powerful balloon to lift up our scientific enterprise. This book in itself represents a sign of it. It is a result of the cooperation agreement signed in 2014 between the University of the Peninsula of Santa Elena (UPSE) and BITrum, which targets at several collaborative activities concerning: the development and co-management – together with the University of León – of the glossariumBITri open journal; the development of educational programs; the cooperation in interdisciplinary research projects. Furthermore, the Ecuadorian National Secretary of Higher Education, Science, Technology and Innovation (SENESCYT) is supporting in the field of interdisciplinary information studies – through the Prometeo Programme –: the development of theoretical work and practical applications, the training of researchers, the development of scientific networks, etc. On one side, BITrum warmly thanks this support to the interdisciplinary study of information provided by the UPSE and SENESCYT; on the other side, we offer our deep commitment to contribute to the great scientific and educational effort Ecuador is doing since the constitution of 2008. We are convinced that the transdisciplinary capabilities of the information studies offers a toehold for the intense integration of knowledge we nowadays need for coping with the complex challenges our societies that are facing regarding the coverage of basic needs, environment, peace, inequality, urban management, climate change, democratic issues, waste reduction… We can use the language of information to refer to the physical, biological, societal, technological reality, to address theoretical and practical issues. Then we have a fantastical tool for weaving the scientific enterprise in a more integrated fashion.

José María Díaz Nafría

Santa Elena (Ecuador), February 2015

Methodological notes

Methodology: **pluralism and rightness**

The *glossariumBITri* is conceived as a *cooperative* work in the following sense: each voice has a responsible editor who regulates, animates and organize the discussion of the term and the different contributions provided by the rest of the authors. It is furthermore an open work in a very particular sense: it is electronically accessible and opened to gather new contributions and discussions at any voice. Hence, subsequent editions will constantly increase the extension and deepness of the different entries.

Furthemore the glossariumBITri *interdisciplinary* insofar it gather scientists from different knowledge areas in which the informational notions play a central role. Moreover, basic concepts are *trans-disciplinary*, as far as they cross different disciplines and fields of knowledge and action. The glossariumBITri does not assume an informational paradigm above others, but it endeavors to expose all coherently without hiding the theoretical and practical conflicts.

According to the conceived methodology for glossariumBITri's elaboration, all editorial team members can participate in any article under the assumption of certain commitments:

— All members of the writing team –which is always open to whomever may be interested– are potential authors of ENTRIES for each proposed voice. Thus, each voice may gather several independent entries, or related through debates or criticism to previous contributions.

— The EDITOR (one per voice) is committed to allocate each entry –with sufficient quality– in the final article in a structured way and without redundancy. At the same time, the editor can ask authors for further clarification or deepening here and there, improving the text, providing references, etc.

— For each article, there is a DISCUSSION space where members can make comments, critics, suggestions, questions to the given entries.

— The COORDINATORS overview the elaboration of the glossariumBITri as a whole and coordinate the development of different tasks related to its development: management and development of the edition system, content review, correction request, layout, call organization, dissemination, etc.

Abbreviations and article organisation

As one can see in the adjacent example, right after the voice the usual designation in Spanish, French and German is shown between brackets, preceded by the initials S., F. and G. respectively.

Immediately after, the scientific or disciplinary usage contexts, in which the article is developed, is indicated between square brackets. The goal has been to point out the field better suited to the usage of the term. Thereby there are voices of specific usage for certain theories (e.g., *self-re-creation* defined in the context of the Unified Theory of Information). On the other hand, "transdisciplinary" has been used in the soft sense of crossing different disciplines (e.g., [transdisciplinary, system theory]).

As subindex going along the list of usage contexts, the object type to which the article refers to is highlighted. It can be: *concept* (e.g., autopoiesis), *metaphor* (e.g., information flow), *theory* (e.g., channel theory), *theorem* (e.g., fundamental theorems of Shannon), *discipline* (e.g., hermeneutics), *problem* (e.g., fotoblogs and adolescents), or *resource* (e.g., semantic web).

In case the article is large, the titles of the sections, in which the article is divided, are enumerated right after the heading.

The article **structure** has been freely determined by the corresponding editors, striving for a systemization of the entries provided by authors or participants in discussions.

For **citation** and bibliographic reference listing and style adapted to ISO 690 standard has been used.

The **authorship** in indicated at the bottom of each article through abbreviations specified in the section devoted to the editorial team. "ed" denotes editor, "tr" translator. If only an abbreviation is indicated at the article bottom this means the corresponding author has not received –or incorporated yet– contributions of other authors.

Additionally other abbreviations and acronyms referred to right after the authors and editors' abbreviation list.

ALGORITHMIC INFORMATION THEORY (S. *Teoría Algorítmica de la Información*, F. *Théorie Algorithmique de la Information*, G. *Algorithmische Informationstheorie*) [Information Theory, Computer Science, Coding theory, Complexity theory] theory

Contents.— *1) Symbolic objects and symbols; 2) Reconstructive sense of algorithmic information; 3) Versions of algorithmic information measures; 4) Algorithmic vs common sense information: object vs carrier of information; 5) Timely and semiotic aspects of algorithmic information with respect to other information meanings.*

Algorithmic information theory is based on the concept of Kolmogorov or algorithmic complexity of objects, which provides means to measure the intrinsic information related to

Editorial Team

Coordinators

José María Díaz Nafría (*Senescyt–UPSE*, Ecuador), jdian@unileon.es

Francisco Salto Alemany (*Universidad de León*, Spain), francisco.salto@unileon.es

Mario Pérez-Montoro (*Universitat de Barcelona*, Spain), perez-montoro@ub.edu

Editors

The following list recaps for each editor the set of articles he is in charge of (in the introductory section devoted to *glossariumBITri*'s methodology the particular role of the editors as to the interdisciplinary elaboration of articles is specified). This list does not reflect the contributions of editors to other voices as authors.

Juan Miguel Aguado (*Universidad de Murcia*): Autopoiesis, Communication; Constructivism; Cybernetic; Endogenous information; Observation

Carlos Aguilar (*Universidad de Barcelona*): Audio-visual content; Situational logic

Basil M. Al Hadithi (*Universidad Politécnica de Madrid*): Automatic regulation; Control Theory; Feedback; Fuzzy logic

Juan Ramón Álvarez (*Universidad de León*): Biosemiotics; Memetics

Leticia Barrionuevo (*Universidad de León*): Open Access; Repository

Søren Brier (*Copenhagen Business School, Denmark*): Cybersemiosis

Luis Emilio Bruni (*Aalborg University*, Denmark): Symbol, Biosemiosis

Mark Burgin (*University of California Los Angeles*, USA): General Theory of Information, Algorithmic Information Theory, Kolmogorov Complexity, Super-recursive

Manuel Campos (*Universitat de Barcelona*): Correlation; Regularity; Representation; Situation semantics; Situation theory (ST); Truth value

Rafael Capurro (*Institut für Digitale Ethik*, Germany): Angeletics; Automatic Identification (Radio-Frequency Identification, RFID); Hermeneutics; Human Enhancements Technologies (HET); ICT implants; Information Ethics; Intercultural information ethics; Interpretation; Message; Roboethics; Surveillance society

María Herminia Cornejo (*UPSE*, Ecuador), Oceanography and information

Emilia Curras (*Universidad Autónoma de Madrid*): Informacionism

José María Díaz Nafría (*Senescyt-UPSE*, Ecuador; *Munich University of Applied Sciences*, Germany; *Universidad de León*, Spain): Alphabet; Code; Communication channel; Context; Dialogic

vs. Discursive; Disinformation; Encoder and Decoder; Fundamental Shannon's Theorems; Holographic Principle; Noise; Sign; Signal

Gordana Dodig-Crnkovic (*Mälardalen University*, Sweden): Info-computationalism

Jesús Ezquerro (*Universidad del País Vasco*): Cognition; Natural Psicology

Juan Carlos Fernández Molina (*Universidad de Granada*): Information Rights

Peter Fleissner (*Technische Universität Wien*, Austria): Commodification; Input vs Output [System Theory]; Reversibility vs. Non-reversibility; System theory

Anto Florio (*Institute for Logic, Language and Computation*, Amsterdam): Intentional Content

Christian Fuchs (*University of Westminster*, UK): Critical Theory of Information, Communication, Media, Technology

Xosé Antón García-Sampedro (*I.E.S. Bernaldo Quirós*, Mieres): Information Aesthetics

Roberto Gejman (*Pontificia Universidad Católica de Chile*): Difference; Record

Igor Gurevich (*Institute of Informatics Problems of the Russian Academy of Sciences*, Rusia) Information as heterogeneity

Wolfgang Hofkirchner (*Technische Universität Wien*, Austria): Capurro's Trilemma; Emergentism; Information Society; Self-re-creation [UTI]; Self-reproduction [UTI]; Self-restructuring [UTI]; Structural information [UTI]; Unified Theory of Information (UTI)

Manuel Liz (*Universidad de La Laguna*): Content; Informational Content; Mental Content; Mind; Non-informational access; Referential ability; Semantic content

Rosa Macarro (*Universidad de Extremadura*): Receiver, Sender, Source

Alfredo Marcos (*Universidad de Valladolid*): Information Measurement; Information as relation

Estela Mastromatteo (*Universidad Central de Venezuela*): Digital divide; Information Literacy; Information Technologies

José Méndez (*Universidad de Salamanca*): Contradiction

Jorge Morato (*Universidad Carlos III*): Information Retrieval; Web social/Social Web; Topic Maps

José Antonio Moreiro (*Universidad Carlos III*): Indexing language; Folksonomy; Taxonomy

Walter Orozco (*Universidad Estatal Península de Santa Elena*, Ecuador), Data Bases

Tomás Ortiz (*Universidad Complutense de Madrid*): Cerebral oscillations

Julio Ostalé (*Universitat de Barcelona*): Barwise, K. Jon; Channel theory; Information Flow; Information Reports

Mario Pérez-Montoro (*Universitat de Barcelona*): Data; Dretske, Fred; Information architecture; Information management; Information visualization; Knowledge; Knowledge management; Propositional content; Usability

Carmen Requena (*Universidad de León*): Emotion; Motor information

Gemma Robles (*Universidad de Salamanca*): Consistency; Paraconsistency

Blanca Rodríguez (*Universidad de León*): Document; Documental content analysis; Library Science

Shendry Rosero (*UPSE*, Ecuador), Telematic Networks

Francisco Salto (*Universidad de León*): Incompleteness; Infomorphism; Infon; Modal logic; Net; Tautology; Turing's Halting Theorem

Lydia Sánchez (*Universitat de Barcelona*): Fotoblogs and Teenagers; Image; Incremental information [ST]

Sonia Sánchez-Cuadrado (*Universidad Carlos III*): Knowledge Organization; Knowledge Organization System; Ontology; Semantic Web; Thesaurus

Jérôme Segal (*Interdisciplinary Centre for Comparative Research in the Social Sciences*, Austria): Claude Elwood Shannon

Washington Torres (*UPSE*, Ecuador), Telecommunication politics

Margarita Vázquez (*Universidad de La Laguna*): Paradox; Surprise; System; Temporal Logics; Virtual

Rainer Zimmermann (*Munich University of Applied Sciences*, Germany; Clare Hall-Cambridge, UK) Network; Space

Other authors

The following authors (not included in the former list) have contributions to the articles specified bellow:

Yorgos Andreadakis (*Universidad Carlos III*): Semantic Web, Social Web

Sylvia Burset (*Universitat de Barcelona*): Image, Fotoblogs and Teenagers, Information Aesthetics

Eva Carbonero (*Universidad Carlos III de Madrid*): Folksonomy

Anabel Fraga (*Universidad Carlos III*): Folksonomy, Semantic Web, Social Web

Mehrad Golkhosravi (*Universitat de Barcelona*): Data; Dretske, Fred; Information Architecture; Information Management; Information Visualization; Knowledge; Knowledge Management; Propositional Content; Usability

Language and style correction

The following were in charge of enhancing grammar and style correctness:

Basil M. Alhadithi (*Universidad Politécnica de Madrid*) (inglés)

Anthony Hoffmann (*University of Wisconsin Milwaukee*, EE.UU.) (inglés)

Rosa Macarro (*Universidad de Extremadura*) (inglés, español)

Mercedes Osorio (*I.E.S. Ramiro de Maeztu*, Madrid) (inglés)

Abbreviations and Acronyms

Abbreviations of authors and editors' names

Abbreviations used at the footing of each article for the identification of the contributors.

AF	Anto Florio	JFM	J.C. Fernández Molina	MPM	Mario Pérez-Montoro
AFV	Anabel Fraga Vázquez	JE	Jesús Ezquerro	MV	Margarita Vázquez
BA	Balu Athreya	JGS	J. A. García-Sampedro	PF	Peter Fleissner
BH	Basil M. Al Hadithi	JM	José Méndez	PM	Pedro Marijuán
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CR	Carmen Requena	JO	Julio Ostalé	RZ	Rainer Zimmermann
EC	Eva Carbonero	JRA	Juan Ramón Álvarez	SB	Søren Brier
ECP	Emilia Curras Puente	JS	Jérôme Segal	SBB	Sylvia Burset Burillo
EM	Estela Mastromatteo	LB	Leticia Barrionuevo	SR	Shendry Rosero
FS	Francisco Salto	LEB	Luis Emilio Bruni	SSC	S. Sánchez-Cuadrado
FV	Freddy Villao	LS	Lydia Sánchez	TO	Tomás Ortiz
GR	Gemma Robles	MB	Mark Burgin	WH	Wolfgang Hofkirchner
GD	Gordana Dodig-Crnkovic	MC	Manuel Campos	WO	Walter Orozco
IG	Igor Gurevich	MG	Mehrad Golkhosravi	WT	Washington Torres
JAM	José Antonio Moreiro	ML	Manuel Liz	YA	Yorgos Andreadakis

Other abbreviations and acronyms used in the glossariumBITri

AIT	Algorithmic Information Theory
EHEA	Europeo Higher Education Area
FIS	Foundations of Information Science
GTI	General Theory of Information
ICT	Information and Communication Technologies
INFOLIT	Information Literacy
LIS	Library and Information Science
MTC	Mathematical Theory of Communication
OECD	Organisation for Economic Cooperation and Development
ST	Situational Theory
UTI	Unified Theory of Information

A

ALGORITHMIC INFORMATION (S. *información algorítmica*, F. *information algorithmique*, G. *algorithmische Information*) [transdisciplinary, ICT] concept, theory

Algorithmic information reflects aspects and properties of information related to algorithms (s. also →*Algorithmic Information Theory*, and →*Axiomatics for Algorithmic Information*). Many information processes, such as network messaging or computer information processing, have algorithmic nature as they are performed according to various algorithms.

Two kinds of algorithmic information are considered: (1) algorithmic information necessary to build a constructive object by a given system of algorithms and (2) algorithmic information in an object, e.g., message, which allows making simpler construction of another object. The most popular measure of algorithmic information of the first type is *absolute Kolmogorov* or *algorithmic complexity*. The most popular measure of algorithmic information of the second type is *relative Kolmogorov* or *algorithmic complexity* (→*Kolmogorov complexity*).

According to the classes of algorithms used for information acquisition, processing and utilization, three types of algorithmic information have been separated and studied:

— **subrecursive** algorithmic information,

— **recursive** algorithmic information (→*Kolmogorov complexity*), and

— **super-recursive** algorithmic information (→*Super-recursive Kolmogorov complexity*).

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ALGORITHMIC INFORMATION THEORY (S. *Teoría Algorítmica de la Información*, F. *Théorie Algorithmique de la Information*, G. *Algorithmische Informationstheorie*) [Information Theory, Computer Science, Coding theory, Complexity theory] theory

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Algorithmic information theory is based on the concept of Kolmogorov or algorithmic complexity of objects, which provides means to measure the intrinsic information related to objects via their algorithmic description length (s. also →*algorithmic information*). As it is generally assumed, this measure was introduced and
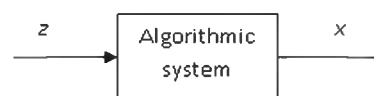
studied by three authors: Ray **Solomonoff** (1964), Andrey **Kolmogorov** (1965) and Gregory **Chaitin** (1966). Algorithmic approach explicates an important property of information, connecting information to means used for accessing and utilizing information. Information is considered not as some inherent property of different objects but is related to algorithms that use, extract or produce this information. In this context, a system (person) with more powerful algorithms for information extraction and management can get more information from the same carrier and use this information in a better way than a system that has weaker algorithms and more limited abilities. This correlates with the conventional understanding of information. For instance, system (person) that (who) has a code C can read codified in C texts, while those who do not have this code cannot read such texts. As a result, *efficiency* or *complexity* of algorithms becomes a measure of information in contrast to the traditional approach when information is treated as uncertainty or diversity. Efficiency is a clue problem and a pivotal characteristic of any activity. Consequently, measures of efficiency and complexity provide means for measuring information as a dynamic essence.

Algorithmic information theory has been **applied** to a wide range of areas, including theory of computation, combinatorics, medicine, biology, neurophisiology, physics, economics, hardware and software engineering, probability theory, statistics, inductive reasoning, and machine learning.

1. Symbolic objects and systems.
Objects considered in algorithmic information theory are *strings* of *symbols* because the most habitual representation of information uses symbols and it is possible to represent other structures codifying them by strings of symbols. It is natural to interpret such strings as words or texts in some language. It means that information is presented and processed in the symbolic form and all systems are represented by their *symbolic* (semiotic) models (→*symbol*). Exact models

have mathematical structure. The main question is how much information we need to reconstruct (compute) a given string (word). Thus, the traditional approach in algorithmic information theory treats only symbolic information. This question relates information to complexity because measure of necessary information appears here as a measure of complexity of the string reconstruction.

2. Reconstructive sense of algorithmic information.
Reconstruction/computation of a string of symbols is an action that is realized as a process. Its complexity depends on means that are used for reconstruction. To make this idea precise a concept of an algorithm is used. Namely, strings are reconstructed (built) by algorithms. Algorithms are working in the domain of strings and this domain usually consists of all finite strings in some alphabet. In this context, an algorithm (it is also possible to say, automaton or computer) takes one string of symbols z and eventually produces another string x, as represented in the following figure.

The input string is a carrier of information about the output string, i.e., string that we are going to reconstruct/compute. It is possible to consider the input string z as the program that has been given to the algorithm/machine for computing x. This program provides information about x for an algorithm (computing device). In such a way, researchers come to information size (complexity) of a string of symbols, which is the theory's fundamental concept. Note that very often, information content of a string is called Kolmogorov complexity. Namely, the information content $C(x)$ of a string x is the minimum quantity of information needed to reconstruct this string. In the conventional approach, such quantity of input information is measured by the size of information carrier and as carriers are strings of symbols the volume of a string z is the length $l(z)$ of this string. Thus, the length of

the shortest program for calculating the output string x gives the measure of information needed to reconstruct/compute this string.

3. Versions of algorithmic information measures. Although this is the most popular information measure in algorithmic information theory, other versions of algorithmic measures of information have been introduced. The most known of then are: *uniform complexity* $KR(x)$, *prefix complexity* or *prefix-free complexity* $K(x)$, *monotone complexity* $Km(x)$, *conditional Kolmogorov complexity* $CD(x)$, *time-bounded Kolmogorov complexity* $C^t(x)$, *space-bounded Kolmogorov complexity* $C^s(x)$, and *resource-bounded Kolmogorov complexity* $C^{t,s}(x)$. In addition, algorithmic information theory has been extended to infinite processes, infinite words (Chaitin, 1976; 1977), →*super-recursive algorithms* (Burgin, 1995; 2005; Schmidhuber, 2002) and quantum computations (Svozil, 1996; Vitanyi, 1999; 2001). Each new development of algorithmic information theory has been connected to considering different classes of algorithms as means for information acquisition, processing and utilization. At first, only subrecursive classes (i.e., subclasses of the class of all Turing machines, such as the class of all delimiting Turing machines) were used for this purpose. Later more powerful, →*super-recursive algorithms*, such as inductive Turing machines were applied to the study of algorithmic information (s. also →*algorithmic information*).

Existence of a variety of approaches and algorithmic measures of information caused a necessity for a unifying approach. This approach called →*axiomatic information theory* was introduced and developed by Burgin (1982; 1990; 2005; 2010).

4. Algorithmic vs common sense information: object vs carrier of information. An essential problem with algorithmic complexity as a measure of information is related to its information theoretical interpretation. It is generally assumed that the algorithmic complexity of a binary string x measures the amount of information in the string x. Thus,

according to the algorithmic information theory, random sequences have maximum complexity as by definition, a random sequence can have no generating algorithm shorter than simply listing the sequence. It means that information content of random sequences is maximal.

Physicists were the first who attracted attention to this peculiarity. For instance, Richard Feynman (1999) wrote:

> *"How can a random string contain any information, let alone the maximum amount? Surely we must be using the wrong definition of 'information'?..."*

To eliminate these contradictions and discrepancies that are prevalent in algorithmic information theory and to solve the problem of correct understanding the meaning of the function $C(x)$, it is more adequate to consider $C(x)$ and all its versions as *measures of information about x* or the *information size of x* with the special goal to build or reconstruct x. It means that in reality, x is not the *carrier of information* measured by $C(x)$, but the *object of this information*. Thus, it becomes not surprising that people, or a machine, need more information about a random sequence of letters to reconstruct it than about a masterpiece, such as a poem by Dante or a novel by Cervantes.

5. Timely and semiotic aspects of algorithmic information with respect to other information meanings. In order to reconcile the common sense of information with the one provided by the algorithmic information theory, the *timely* distinction introduced by Weizsäcker (1984) between *potential* and *actual* information is also fruitful (Lyre, 2002). In our case, while the aforementioned carrier (z in the figure above) represents *potential information* (i.e. the possibility to reconstruct x), the object of information x represents *actual information* when the algorithmic system has effectively reconstructed it. By abstracting the algorithmic resources and therefore addressing to an alleged optimal means, the specificity of z with respect to a given algorithmic system is lost

and only the objective of reconstruction, x, prevails. To this respect algorithmic information can be seen as actual information. On the contrary, the information concept provided by the Mathematical Theory of Communication (MTC), information entropy, exclusively refers to the degree of uncertainty at the recipient before being informed, thus abstracting the specific outcome. This shows that information entropy has a fundamental potential character complementary to algorithmic information.

The semiotic distinction between syntactic and semantic aspects offers as well some insights to distinguish algorithmic information from other senses of information. As argued by Lyre (2002) algorithmic information – unlike →*Shannon*'s information – reflects, at the same time, semantic and syntactic aspects: "The algorithmic information content measures actual information under both syntactic and sematic aspects" (Lyre 2002, p. 38). In our context, x can be regarded as the semantic value of the algorithmic information or process (note x may be a set of operations with a particular effect on the environment, for instance, a manufacturing process, therefore it reflects not only semantics but also pragmatics), whereas z represents its syntactical value. In the invariant form of algorithmic information, z corresponds to the minimal syntactics to address the object semantics represented by x. On the contrary, is well known that MTC programmatically restrict information to its syntactic dimension.

These same distinctions are to some extent also used in the common senses of information. When we consider that we need information, this is regarded in its potential value. While when we say that we have the information someone need, this is regarded in its actual value, though what we factually have is some z that might eventually be shared and we suppose the third party has the algorithmic means (as we do) to reconstruct some x, which for some reason might be cherished. Then having z is practically equivalent to having x.

Although it would not be formulated as such, it is commonly clear that z has a syntactical value, whereas x has a semantic one.

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(MB –ed.-; MB, JMD)

ALPHABET (S. *alfabeto*, F. *alphabet*, G. *alphabet*) [transdisciplinary, ICT] concept, resource

The term (from Latin *alphabētum*, and this from Greek *άλφα*, alfa, and *βῆτα*, beta) has been originally used to refer to the writing system whose symbols (letter) are in relative correspondence with *phonemes* of the spoken language, in contrast to those writings in which the correspondence is established with *morphemes* or *syllables*. However, the usage has been extended to refer to the set of symbols employed in a communication system. This is the sense normally used in communication theory and particularly in the model of information transmission (especially in its syntactic level, such as in

the case of MTC), labelling the finite set of symbols or messages that make up the →*code* which must be known for both the emitter and receiver.

There are two fundamental features to characterise the alphabet with regard to its *performance in communication efficiency*: 1) its *adequacy to the constraints* of the communication channel (e.g., that the stroke could be continuous or not, or that the spectral content had to be limited to a given range); 2) the *differentiability* of its component symbols. The former because it will just be effective whatever succeeds in crossing the channel; the latter because depending on it the reception in noisy environments will be better or worse. Indeed, Kotelnikov (1959) proved that the detection error probability is a function of such differences (measured in terms of energy with respect to the noise spectral density).

Concerning alphabets coming from natural languages, they exhibit relevant features regarding an efficient coding for transmission through artificial channels: 1) the *statistical frequency* of each symbol, and 2) the *statistical dependence* between a symbol and its adjacent ones (i.e., the transmission probability of a symbol j when the previous was i or a given sequence). The observation -by Alfred Vail- of the first feature in the development of the Morse code played a major role in the success of Morse Telegraph (Oslin 1992) and probably, it played an important heuristic role in the forging of the concept of information measure, especially in Hartley and Shannon work (Lundheim 2002, Segal 2003). The last one accounts for both features in his famous "Mathematical Theory of Communication" in order to determine the *entropy* (or *information amount*) of a source (Shannon 1948).

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(JMD)

ANGELETICS (S. *angelética*, F. *angeletique*, G. *Angeletik*) [Communication theory, Information ethics] concept

Contents.— *1) What is angeletics?, 2) To what extent is this a new science?, 3) A transparent society?, 4) A time of empty angels, 5) From hermeneutics to angeletics, 6) Conclusion*

1. What is angeletics? It is the name of a field of philosophic and scientific research. Why is it called like that? The word 'angeletics' derives from Greek *angelia*, meaning message. We use it when we refer to angels or divine messengers. There is a long tradition in theology and religious studies called angelology. Angeletics is different from angelology, its purpose being to study the phenomenon of messages and messengers within the boundaries of the *condition humaine*, i.e. having as its primary object human communication. This does not imply that studies relating to messages and messengers in religion or the natural sciences are excluded. Since the Internet, digital messages and messengers are playing an important role in social communication.

2. To what extent is it a new science? It is evident that the social phenomenon of messages and messengers is a vast, old and complex phenomenon. The industrial revolution has attributed a lot of value to the marketing theory, that is, the study of propagating messages to obtain economic benefits. Moreover, when we go back to the cultural revolution caused by the invention of the press we can perceive the influence of this technique in the worldwide dissemination of political, religious and economic messages in modern times. We should not forget the history of the technique and organization of the post offices and, last

but not least, the history and theory of relations between the states based on embassies and ambassadors.

3. A transparent society? The technical revolution of the printing press creates a new situation that is both informative and angeletic. Immanuel Kant sees in the non-censored distribution of scientific research through the press the medium in which the ideals and messages of Enlightenment can spread and indirectly influence public politics. Since then new political and (pseudo)-scientific messages appeared seeking to occupy the place of religious messages and messengers with catastrophic consequences for society and nature, making full use as, for instance, in the case of Nazi Germany, of radio-diffusion. The peak of mass media, through its one-to-many structure, opened the debate about the task of creating a public space free of pressure structures, where the force of the arguments and reasoning of the players has precedence. This was the ideal proclaimed by philosophers like Jürgen Habermas. According to Habermas, Kant could not foresee the transformation of the public space dominated by mass media (Capurro, 1996a). Italian philosopher Gianni Vattimo, in his turn, criticized the Habermasian transparent society, with emphasis on its utopian aspect and leveler of differences, so that a "weaker" or less transparent structure permits different kinds of cultural mixes that are more clearly reflected today in the decentralizing character of the Internet (Vattimo 1989).

4. A time of empty angels. German philosopher Peter Sloterdijk has pointed out that we live in a "time of empty angels" or "mediatic nihilism", in which we forget what message is to be sent while the messengers of transmission media multiply: "This is the very *disangelium* of current times" (Sloterdijk 1997). The word *disangelium* (por bad news) stands out, in contrast to *euangelium*, for the empty nature of the messages disseminated by the mass media, culminating in the widely-known words of

Marshall McLuhan: "The medium is the message". The question then is exactly to what extent the Internet creates a new angeletic space giving rise to new synergies of messages and messengers beyond the hierarchical and absolute or pseudo-absolute character of sacred messages or their political substitutes. If, according to Sloterdijk (1983), mass media have a cynical structure, the question arises now about the "fantasmatic" character of the new media (Zizek 1997, Capurro 1999a).

Based on that, we now reach what we call →*information ethics*, aimed at explaining the possible theoretical and practical horizons in order to maintain, organize and create new forms of common life. This current praxeological horizon explored by the information ethics is given in a world where, on the one hand, the classic parameters of time and place are questioned as determining factors for the creation and diffusion of messages; on the other hand, the local structures of political power up to now controlling such a phenomenon are now paradoxically in the inverse situation. The great economic and social (r-)evolutions are founded less on the prevalence of media to produce material objects, as Karl Marx thought, than on the media to communicate messages. The latter are the basis of the former (Capurro, 1995, 1999).

5. From hermeneutics to angeletics. Lastly, I would like to mention the relationship between angeletics and hermeneutics (Capurro, 2000b). Hermeneutics was one of the main schools of philosophical thought in the 20th century. Apart from the disputes between schools (positivism, Marxism, critical rationalism, analytical philosophy, scientific theory, etc.), we can say that one of the great results of the study on the 20th century has been the awareness of the interpretative nature of human knowledge. This is valid both for Karl Popper, for example, who presented a characterization of scientific knowledge as being an eminently conjectural knowledge, subject to empirical falsifications, or for the "hermeneutic circle" explained by Hans-Georg Gadamer

with basis on Heideggerian analytics. Each interpretation presupposes a process of message transmission. Hermes is first and foremost a messenger and, consequently, an interpreter and translator. This message-bearing nature of knowledge and communication is exactly angeletics aims to analyze. Of course, this is just as complex and far-reaching a task as hermeneutics was in the last century.

6. Conclusions. A s angeletics is a message theory, it is in itself only a message aiming to create common knowledge, which might become a key-science for the newly-born century. Its issues relate to the origin, purpose and content of messages, power structures, techniques and means of diffusion, ways of life, history of messages and messengers, coding and interpreting, and psychological-, political-, economical-, aesthetical-, ethical- and religious aspects. In other words, a new scientific cosmos. We are far away from such a science of messages and messengers as well as from its philosophical foundations.

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(RC)

AUDIO-VISUAL CONTENT (S. *contenido audiovisual,* F. *contenus audiovisuels,* G. *audiovisueller Inhalte*) [transdisciplinary, ICT] concept

The audio-visual content has a double relation with information. As physical objects they can be observed as carriers of information about their own nature and given the transmitted content, can also be considered as information carriers, in the terms of the Unified Theory of information. UNESCO's Memory of the World Program recognizes that documents, including audiovisual documents, have two components: the information content and the carrier on which it resides.

The value of information often depends on how easily it can be found, retrieved, accessed, filtered and managed. An incommensurable amount of audiovisual information is becoming available in digital form, in digital archives, on the World Wide Web, in broadcast DataStream and in personal and professional databases, and this amount is only growing. In spite of the fact that users have increasing access to these resources, identifying and managing them efficiently is becoming more difficult, because of the growing volume. The question of identifying content is not just restricted to database retrieval applications such as digital libraries, but extends to areas like broadcast channel selection, multimedia editing, and multimedia directory services.

Furthermore, images are rich in contents, while in many applications text may not be

rich enough to describe images in an effective way. To overcome these difficulties, in the early 1990s, content-based image retrieval emerged as a promising means for describing and retrieving images. Content-based image retrieval systems describe images by their own visual content, such as color, texture, and objects' shape information rather than text. In 1996 MPEG recognize the need to identify multimedia content, and started a work item formally called 'Multimedia Content Description Interface', better known as MPEG-7.

The Moving Picture Experts Group (MPEG) is a working group of ISO/IEC (formally ISO/IEC JTC1/SC29/WG11) in charge of "development of international standards for compression, decompression, processing, and coded representation of moving pictures, audio, and their combination, in order to satisfy a wide variety of applications".

This standard includes the description of physical characteristics of the image but MPEG-7 also includes Descriptors that define the syntax and the semantics of the image. The specific structure, semantics and relationships among the components of the content are collect in Description Schemes. There are two different schema types: Descriptors and Description Schemes.

According to this philosophy, the MPEG-7 descriptors of the audio-visual content may include all the items that the standard considers as informative:

— Information describing the creation and production processes of the content (director, title, short feature movie).
— Information related to the usage of the content (copyright pointers, usage history, broadcast schedule).
— Information of the storage features of the content (storage format, encoding).
— Structural information on spatial, temporal or spatio-temporal components of the content (scene cuts, segmentation in regions, region motion tracking).

— Information about low level features in the content (colors, textures, sound timbres, melody description).
— Conceptual information of the reality captured by the content (objects and events, interactions among objects).
— Information about how to browse the content in an efficient way (summaries, variations, spatial and frequency sub bands,).
— Information about collections of objects.
— Information about the interaction of the user with the content (user preferences, usage history).

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(CA)

AUTOPOIESIS (S. *autopoiesis*, F. *autopoïèse*, G. *Autopoiesis*) [system theory, cibernetics, theory of social systems] concept

(αυτο-ποιησις, 'auto (self)-creation'), neologism introduced in 1971 by the Chilean biologists Humberto *Maturana* and Francisco *Varela* to designate the organisation of living systems in

terms of a fundamental dialectic between structure and function. Although the term emerged in biology, afterwards it came to be used in other sciences as well. Its use by the sociologist Niklas *Luhmann* is worth pointing out. It can be said that the →*UTI* takes and reproduces the concept in more differentiated categories (→*self-restructuring, self-reproduction* and *self-recreation*).

For *Maturana* and *Varela*, autopoiesis is a fundamental condition for the existence of living beings in the continuous production of themselves. According to Maturana (Transformation in coexistence), "living beings are networks of molecular production in which the produced molecules generate, through their interactions, the same network that creates them". Autopoietic systems are those that show a network of processes or operations that characterise them and which have the capacity to create or destroy elements of the same system as a response to the disturbances of the medium. Within them, even if the system changes structurally, the network that characterises them would remain invariable during its whole existence, maintaining its identity.

For *Luhmann*, autopoiesis means a new theoretical paradigm, which, if applied to social systems, has a self-referential nature that does not restrict itself to the structural level; the nature itself constructs the elements that make it up. So, whereas in biological systems self-reference corresponds to self-reproduction, in social (or psychic) systems, it is constituted through meaning (Sinn), which, in its turn, is produced by the "processing differences" which permit to "select" from the "meaning offer" (Mitteilung). According to the Luhmannian interpretation, "communication" (Kommunikation) melts the difference between "information" (Information), the "meaning offer" (Mitteilung) and "understanding" (Verstehen) (in which each part differentiates the other two and leads them towards a unity), where the information is but a selection within the "meaning offer" through

a connection between differences. Therefore, there would not be strictly a transmission of information between emitter and receiver; instead, the first one makes a suggestion for the selection of the second one, so that the information for both is different, although, in any case, it is constituted through communication pro-cesses.

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(JMA –ed.-; JMD)

AXIOMATICS FOR ALGORITHMIC INFORMATION (S. *Axiomatica de la Información Algorítmica*, F. *Axiomatique de l'information algorithmique*, G. *Axiomatik für die algorithmische Information*) [AIT, Complexity theory, Computer science, Coding theory] theory

Contents.— *1) Direct information sizes; 2) Dual complexity measures; 3) Origin and advantages of the axiomatic approach to algorithmic information*

The existence of a variety of algorithmic measures of information brought forth a necessity for a unifying approach (→*Algorithmic information theory*, and *Algorithmic information*). This approach has been called axiomatic information theory.

Algorithmic information measures information that is necessary to construct (build) a constructive object by means of some system of algorithm **A**. That is why algorithmic information is dual to a *static complexity* measure (*static direct information size*) a of a constructive object x and is called by the name (**A**, α)- *information size* of x. Dual information size is constructed from direct information size by the minimization operation. For instance, a natural direct information size for algorithms/programs is the length of their description (symbolic representation), and the same is true for

data. It is possible to measure length in such natural units of information as bits and bytes. When taking the dual to this measure in the class of recursive algorithms, we obtain Kolmogorov complexity or recursive information size (→*Kolmogorov complexity*).

The axiomatic description of dual information size uses axiomatic descriptions of direct complexity measures suggested by Blum (1967; 1967a) and further developed by Burgin (1982; 2005; 2010).

1. Direct information sizes. All kinds of *direct information sizes* are divided into three classes:

1) *Direct static information size* depends only on an algorithm/program that is measured. Direct static information size usually reflects information in the algorithm/program representation. The length of a text (of an algorithm) measures information in bits. If we say that a memory has the capacity 1 gigabytes, it means that it is possible to store 8×10^9 bits of information in this memory.

2) *Direct functional information size* depends both on an algorithm/program that is measured and on the input. Examples of a direct functional information size are such popular measures as time of a computation or space used in a computation.

3) *Direct Processual information size* depends on an algorithm/program, its realization, and on the input. Examples of a direct processual information size are time that it takes to process given input or the number of data transactions between memories of different type used in this process.

2. Dual complexity measures. Information size, or algorithmic complexity, can be defined for different classes of algorithms, resulting in different measures. However, all these measures are constructed by a similar technique. As a result, it is possible to axiomatize this approach. The result of this axiomatization is called *dual complexity measures* (Burgin, 2005). As before, we are going to call these measures by the name *dual information size* as

they reflect information necessary to compute (construct) a given object. These measures give much more opportunities to estimate information size of words and infinite strings than conventional types of information size (→*Kolmogorov complexity*).

Let $\mathbf{A} = \{A_i ; i \in I\}$ be a class of algorithms, A be an algorithm that works with elements from I as inputs and $\alpha : I \to \mathbf{N}$ be a direct static information size of algorithms from a class $\mathbf{A}$ that satisfies axioms from (Blum, 1967) or (Burgin, 2005, Ch.5). Elements of I are usually treated as programs for the algorithm A.

The **dual to α complexity measure** or (A, α) – *information size* α_{A^c} of an object (word) x with respect to the algorithm A is the function from the codomain (the set of all outputs) Y of A that is defined as

$$\alpha_{A}{}^\circ(x) = \min \{\alpha(p); p \in I \text{ and } A(p) = x\}$$

When there is no such p that $A(p) = x$, the value of $\alpha_{A}{}^\circ$ at x is undefined.

When there is no such p that $A(p) = x$, the value of $\alpha_{A}{}^\circ$ at x is undefined.

When the class $\mathbf{A}$ has universal algorithms, the **invariance theorem** is proved stating that $\alpha_{U}{}^\circ(x)$ where U is a universal algorithm in the class $\mathbf{A}$ is an optimal – in some sense – measure in the class of all measures $\alpha_{A}{}^\circ(x)$ with A from the class $\mathbf{A}$ (Burgin, 2010). This allows one to take $\alpha_{U}{}^\circ(x)$ as an axiomatic complexity measure (axiomatic information size) in the class $\mathbf{A}$.

3. Origin and advantages of the axiomatic approach to algorithmic information. An axiomatic approach to algorithmic information theory was introduced by Burgin in a paper presented for publication by Kolmogorov (Burgin 1982) and further developed in the paper (Burgin, 1990) and in books (Burgin 2005; 2010). The axiomatic approach encompasses other approaches in the algorithmic information theory. It is possible to treat different measures of algorithmic information as particular cases of axiomatically defined

measures of algorithmic information. Instead of proving similar theorems, such as the basic invariance theorem, for each particular measure, it is possible to easily deduce all such results from one corresponding theorem proved in the axiomatic setting. This is a general advantage of the axiomatic approach in mathematics.

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CHANNEL THEORY (S. *teoría de canales*, F. *théorie des canaux*, G. *Kanaltheorie*) [logic, semantics, computer science] theory

Contents.— *1) Formulation of the subject matter, 2) Information flow in a distributed system, 3) Information channels, 4) Information flow: the ideal case, 5) Information flow: the practical case, 6) Fallibility in the flow of information, 7) Two versions of the theory.*

Channel Theory (also known as the Theory of Information Channels, the Theory of Information Flow or simply IF-Theory) is a logico-mathematical theory that models the flow of information among components of a so-called "distributed system". Barwise and Seligman (1997) is the standard source. There are previous versions of the theory that are acknowledged by the same name; in the last section we will deal with that problem.

1. Formulation of the subject matter. There is a fundamental question that channel theory tries to answer: "How is it possible for one thing to carry information about another?" (Barwise and Seligman 1997: xi). Since entities convey information about each other as far as they are classified by abstract states, and moreover the conveyed information depends also on certain background of connections (between things) and regularities (between abstract states), any answer to a particular instance of the previous question has to fit the following scheme (Barwise and Seligman 1997: 13).

Information report:

The fact that a is in the abstract state F carries the information that b is in the abstract state G with respect to certain relationships that link a and b on the one hand, F and G on the other.

It does not matter what a, b, F, G are. It might be the case that a, b are objects and F, G are properties (as in monary predicate logic); perhaps a, b are situations whereas F, G are situation types (as in situation theory); maybe a, b are different instants a system goes by, while F, G are system descriptions in the form of tuples consisting of numbers (as in mathematical modelling). The point is that every part of a distributed system consists of a collection of tokens $\{a_1, a_2,...\}$ as well as a collection of types $\{F_1, F_2,...\}$; both collections relate to each other by means of a classificatory relation, giving rise to items of the form "a is F".

This account of information reports goes back to Dretske (1981). It was partially developed in the theory of situations of Barwise and Perry (1983), which Devlin (1991) updates. In situation theory, regularities between F and G were studied under the name of "constraints", but physical connections between a and b were hardly taken into account. Restrictions serve to explain appropriately the *relativity* of information flow, while the combination of restrictions and connections seems to be the key to understand his *fallibility*.

2. Information flow in a distributed system. Even though information is not defined, it is assumed as something that "flows" among the components of a system. Such components may be distant from one another in time and space; furthermore, they can be very different one to each other. That is why it is said that the system is "distributed" (in computer science this term has another meaning). Example: all the noticeboards, travel tickets and trains that make up a railway network form together a distributed system.

There are systematic correlations among components in every distributed system. They are "regularities" that support the system's information flow, which in turn can be modelled by different theoretical constructs we call "information channels".

There are four principles of information flow. They lead the mathematical development of the theory.

4) Information flow results from regularities in a distributed system.

5) Information flow crucially involves both types and their particulars.

6) It is by virtue of regularities among connections that information about some components of a distributed system carries information about other components.

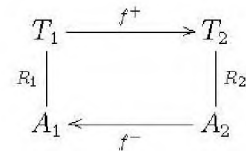7) The regularities of a given distributed system are relative to its analysis in terms of information channels.

Let us see how to formalize the concepts of distributed system and information channel in such a way that they match the above four principles.

3. Information channels. Parts of a distributed system are modelled as classifications. A classification **A** is a structure (A, T, R) where A and T are non-empty sets of tokens and types respectively, and R is a relation from A to T. There might be tokens classified by several types, as well as types that classify several tokens. If a is in A and t is in T, then aRt means that a is of type t.

A classification provides the vocabulary (via T) and the context (via R) whereby it is possible to speak about each component of the system. Typically, different tokens of a classification can be seen as the same physical system across different time points; types would be state descriptions of the system.

Two classifications $\mathbf{A}_1 = (A_1, T_1, R_1)$ and $\mathbf{A}_2 = (A_2, T_2, R_2)$ can be related one to another by means of an infomorphism f from $\mathbf{A}_1$ to $\mathbf{A}_2$, where $\mathbf{A}_1$ is the domain and $\mathbf{A}_2$ the codomain of f. Intuitively, an infomorphism is a "part-to-

whole" informational relationship. It is built up by two functions $f = (f^+, f^-)$ that go in opposite directions (see diagram) and fulfill the following condition: $f^-(a) R_1 t$ if and only if $aR_2 f^+(t)$ for all a in A_2 and t in T_1. This implies that the image of type t says in $\mathbf{A}_2$ what t says in $\mathbf{A}_1$.

$$
\begin{array}{ccc}
T_1 & \xrightarrow{\ f^+\ } & T_2 \\
{\scriptstyle R_1}\Big\downarrow & & \Big\downarrow{\scriptstyle R_2} \\
A_1 & \xleftarrow[\ f^-\ ]{} & A_2
\end{array}
$$

Vertical lines represent classificatory relations; horizontal arrows are functions. Since the direction of f^+ determines that of f we can also write:

$$
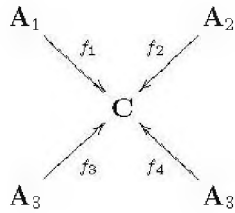\mathbf{A}_1 \xrightarrow{\ f\ } \mathbf{A}_2
$$

We do not consider subscripts in R_1 and R_2 whenever it does not give rise to misunderstanding. In the diagrams we can do without the expressions R_1 and R_2.

Barwise and Seligman (1997: 34, 76) define an information channel as a collection of infomorphisms that share the same codomain. We can also say that a channel consists of a set $\{\mathbf{A}_1, ..., \mathbf{A}_n\}$ of classifications that represent the parts of the distributed system, a classification $\mathbf{C}$ (the core) that represents the system as a hole, and a set of infomorphisms $\{f_1, ..., f_n\}$ that go from each of the parts onto $\mathbf{C}$. Classifications in $\{\mathbf{A}_1, ..., \mathbf{A}_n\}$ can be repeated. Tokens in $\mathbf{C}$ are the connections of the system: of every c in $\mathbf{C}$ it is said that it connects the tokens to which c is related by means of $\{f_1, ..., f_n\}$. Parts $\{\mathbf{A}_1, ..., \mathbf{A}_n\}$ inform about each other as long as they all are parts of $\mathbf{C}$.

Every channel models those conditions that make the information flow possible in a distributed system, which in turn can be modelled by different information channels. A distributed system D is a collection of elements informing about each other. Formally, D consists of an indexed class cla(D) of classifications together with a class inf(D) of infomorphisms whose domains and codomains are all in cla(D).
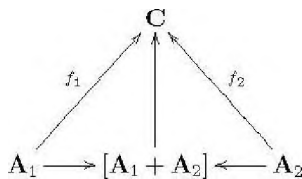
An information channel K covers a distributed system D if and only if cla(D) are the classifications of the channel and for every infomorphism f in inf(D) there are infomorphisms from both the domain and codomain of f to the core of K such that the diagram formed by these three infomorphisms commutes. The underlying idea is that all classifications in the distributed system are informational parts of the core whose channel covers the system. In Barwise and Seligman (1997: 89-97) it is shown how to construct an information channel out of a distributed system.

An information channel with four components could be e.g. a flashlight of which we consider the bulb (A_1), the switch (A_2), the batteries (A_3) and the case (A_4). The corresponding diagram:

Information flows across the channel: switch being ON and battery being charged inform that the bulb is lite unless the case is broken; battery working properly informs that the bulb can be either lite or unlite, etc.

It is possible to simplify a channel so that it contains only two classifications and one infomorphism. In order to do that we get together its parts A_1, A_2, A_3... in a sole classification by means of a "sum" that generates the classification $[A_1+A_2+A_3...]$ where all the information that the parts of the channel previously contained separately is now contained in a single classification. In the case of a channel with two parts:
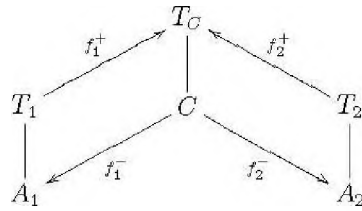

Tokens of $[A_1+A_2]$ are ordered pairs that combine all the tokens in A_1 and A_2. The type set of $[A_1+A_2]$ is the disjoint union generated by types in A_1 and A_2. A token is of certain type if any of its components was of that type. Infomorphisms from the parts to the sum and from the sum to the core are defined so that the diagram commutes.

4. Information flow: the ideal case. Information channels tell us *why* the information flows within a distributed system; which are the conditions of possibility of information. The logical apparatus we present in this section and the next one is suitable for studying *how* that information flows.

Every classification A is equipped with its own "theory", namely the class of regularities among types that are supported by the tokens. How to formalize this idea of regularity that depends on the idea of classification? If T_1, T_2 are subsets of T, then a token a of A satisfies the pair (T_1, T_2) if and only if aRt for all t in T_1 implies aRt for some t in T_2. Every pair (T_1, T_2) satisfied by some token is a regularity.

The theory Th(A) generated by A is a structure $(T, \Rightarrow)$ consisting of the set T of types in A together with a consequence relation $\Rightarrow$ comprised by all regularities in A. Given a theory, we write $T_1 \Rightarrow T_2$ and say that T_1 implies T_2 whenever (T_1, T_2) is a regularity of the theory. Relation $\Rightarrow$ obey the logical properties of identity, monotony and cut that characterize deductive inference.

Once we have the concepts of classification, theory, infomorphism and information channel, it is feasible to try out a first analysis of information flow. Let be given a channel K wherein two classifications A_1 and A_2 inform one about another in virtue of their informational memebership C. The diagram looks like this:

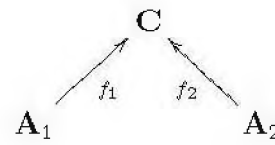*Initial proposal:* Let a_1 be of type t_1 in A_1 and a_2 of type t_2 in A_2. Then a_1's being of type t_1 in A_1 informs that a_2 is of type t_2 in A_2, relatively to the channel K, if and only if a_1 and a_2 are connected through some token in C and moreover $f^+(t_1)$ implies $f^+(t_2)$ in the teory Th(**C**) (Barwise and Seligman 1997: 35).

This first analysis bears in mind regularities in **C** instead of regularities among the parts of the system. This is because we have adopted a viewpoint external to this system, assuming as well that we are given complete information about its regularities. We have idetified that information with Th(**C**). But in practice it is unlikely, if not impossible, that we know all these regularities. That's why it is convenient to revise the previous analysis: we have to assume an internal viewpoint with respect to the system, wherein we are so to speak considering just a part of the system; from observation of that part -together with our incomplete and fallible knowledge of the system as a whole- we have to extract information about other parts of the system. How to do this? By means of local logics.

5. Information flow: the practical case.
Given a classification **A**, its theory Th(**A**) is sound and complete. But we can consider logical systems associated to **A** that are neither sound nor complete. It is precisely what local logics are all about. Motivation for considering such systems comes from the study of situations in which we have the theory of a "proximal" classification A_1 but we want to reason about a "distal" classification A_2 from what we know about A_1. Example: we drive a car and the proximal classification consists of the speedometer, counting machine, gasoline indicator, and so on, whereas the distal classification is the engine.

In general, for all infomorphism f from **A** to **B** there are two rules Intro-f and Elim-f for moving regularities from **A** to **B** and from **B** to **A** respectively. Intro-f translates $T_1^{-f} \Rightarrow T_2^{-f}$ in **A** into $T_1 \Rightarrow T_2$ in **B**. Elim-f translates $T_1^{f} \Rightarrow T_2^{f}$ in **B** into $T_1 \Rightarrow T_2$ in **A**. By means of Intro-f, validity is preserved, while non-validity is not; by means of Elim-f, non-validity is preserved, while validity is not. Closer analysis of rules Intro-f and Elim-f suggests that we should generalize the concept of theory in order to cover logical systems that are possibly unsound or incomplete.
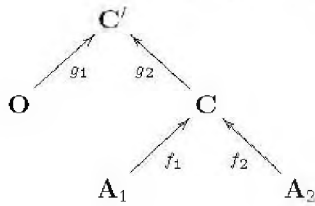
In the car example, as we apply Intro-f_1 to the theory Th(A_1) we get a consistent theory that might not be complete, and as we apply Elim-f_2 to that theory we get a third one (this time over A_2) that might be unsound or incomplete or both.

A local logic $L = (A, \Rightarrow, N)$ consists of a classification A, a binary relation $\Rightarrow$ on type sets from A satisfying identity, monotony and cut, as well as a subset N of "normal" tokens from A satisfying all pairs (T_1, T_2) such that $T_1 \Rightarrow T_2$. Logic L is sound if every token is normal; it is complete if for every pair (T_1, T_2) satisfied by every normal token, it is true that $T_1 \Rightarrow T_2$. The sound and complete local logic of **A** is Log(**A**), which is but a generalization of Th(**A**).

If we have in the previous diagram a local logic $L(A_1)$ associated to A_1, we can define the logic $f_1[L(A_1)]$ generated by Intro-f_1 from $L(A_1)$ and associated to **C**, as well as the logic $f_2^-[f_1[L(A_1)]]$ generated by Elim-f_2 from the former logic and associated to A_2. The last logic might be unsound or incomplete, but it is all we have to reason about A_2 from the starting point of the local logic $L(A_1)$. In general, it can be proved that every local logic associated to a classification is the local logic induced by

some binary channel, i.e. for every classification A_2 and local logic associated to it there exists a classification A_1 and a channel linking both classifications such that the local logic associated to A_2 is of the form $f_2^-[f_1[Log(A_1)]]$.

Does this fact bear any relation at all with our logical model of information flow? Let us suppose there is a channel equipped with two components, as in the former diagram, but this time we do not have Log(C) for the core C. What we have is a local logic L on C that might be either unsound or incomplete. Hence C can be seen as the distant classification of a new channel whose core is C' and whose "proximal" classification O (for observer) supports the logic Log(O), which is the logic the observer uses to reason C. It turns out that L on C equals to $g_2^{-1}[g_1[Log(O)]]$

As we take L instead of Th(**C**) we overcome the initial proposal because we assume now that our knowledge about **C** is incomplete and fallible, for it is the knowledge of an observer that tries to acquire information about A2 from direct access to A_1. But we still have to define the flow of information on the basis of regularities taking place among parts of the system, not on the basis (as in the initial proposal) of regularities among images of types within the core of the channel. In order to move forward we have to simplify the channel by means of the sum operation until we get a channel made up by a single component **A** and a single infomorphism f (otherwise we should have regularities within each part of the system instead of regularities among those parts). At this point we use the rule Elim-f for getting $f^{-1}(L)$, a local logic on **A** that happens to be the "distributed logic" or logic that codifies the information flow of the channel. In other words:
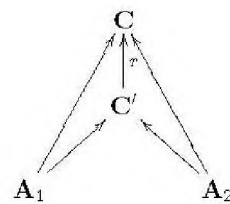
Basic proposal: Given a channel with only one infomorphism, its distributed logic is the inverse image of the local logic associated to the core (Barwise and Seligman 1997: 183).

This proposal is somehow less explicit than the previous one in that it does not mention the "information report" of the first section. However, it is obviously coherent with such a scheme. To see it you only have to work out the basic proposal having into account the concepts involved in the sum of classifications.

6. Fallibility in the flow of information.

Whether a pair of types (T_1, T_2) is a regularity or not, with respect to a distributed system, depends on the information channel we use to model the very system (recall principle 4). And this in turn depends on the analysis we adopt, as well as the tokens and types being assumed. As soon as we fix a distributed system, changing the channel might imply a change in the regularities we are to accept, hence a change in the flow of information our logical model captures.

A way of restricting the number of regularities in a channel **K** is to "refine" it by means of a channel **K'** that has the same parts as **K** yet a different core **C'** that lies between **C** and the parts in such a way that the following diagram commutes.

A straightforward case is that where functions in r are identities and **C'** contains more tokens than **C**. From this case it should be obvious that, the more refined a channel, the more reliable the information it supports, since the number of connections between tokens of different parts of the system increases. With respect to the types: by Intro-r every regularity in **K'** is a regularity in **K** as well; now, by Elim-r not every regularity in **K** is a regularity in **K'**.

CHANNEL THEORY

This means that whenever a regularity in K fails (because of exceptions) we do not have to seek alternative logics but alternative channels.

Suppose that A_1 classifies the switch of a flashlight at different times, whereas A_2 classifies the bulb of the very same flashlight again at those times. If C does not take into account connections with the battery, it is a regularity that the image of the type "on" implies the image of the type "lite". As soon as a flashlight with a discharged battery plays the role of a counterexample to that regularity, we do not have to seek a new logic (e.g. non-monotonic), rather we should try to define a new core C' that takes into account the battery as a relevant component of the flashlight, thus the new channel would not admit as a regularity that the image of "on" implies the image of "lite".

7. Two versions of the theory. There are two versions of channel theory. The second one is a development of the first one, which in turn stems from situation theory. Both versions originate in the collaborative work of Jon Barwise and Jerry Seligman during the 1990s.

First version. The first published paper is Barwise (1992). There it is suggested that situation theory cannot explain fallibility in the information flow because it considers relationships between types of situations without paying attention to relationships between concrete situations. Such relations are introduced and the resulting model is analyzed. Barwise (1993) is a much more sophisticated exposition. Seligman (1990, 1991a, 1991b) had developed very similar ideas to those of Barwise independently. From collaboration of these two authors arise the technical paper Barwise and Seligman (1993) and the more philosophical Barwise and Seligman (1994). This version of the theory was summarized in the survey paper Moss and Seligman (1994).

Second version. The first and still standard reference is Barwise and Seligman (1997), where the previous version of the theory is reformulated in the mathematical framework of category theory, in particular the theory of Chu

spaces (Barr 1979; Pratt 1999). Algebraic constructions over Chu spaces provide the semantics of the theory. Barwise (1997) investigate linkages to modal logic, whereas Barwise (1999) is an application of the theory to the study of non-monotonic reasoning. Seligman (2009), in turn, is an attempt of merging the second version of channel theory with Shannon's statistical theory of signal transmission and codification (1948).

Pérez-Montoro (2000, 2007) takes the viewpoint of information content in his comprehensive survey of Shannon, Dretske, situation theory and the first version of channel theory. Restall (2005) deals with the first version of the theory from a logical perspective. Some recent surveys of information theories, like Devlin (2001) or Bremer and Cohnitz (2004), devote a separate chapter to the second version of channel theory.

Related resources

— Ontologos: http://www.ontologos.org/
— The Information Flow Framework: http://suo.ieee.org/IFF/

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(JO)

CODE (S. *código*, F. *code*, G. *Kode*) [transdisciplinar, communication theory, cybernetics, semiotics] concept

Code is a system of signs and rules for converting a piece of information (for instance, a letter, word, or phrase) into another form or representation, not necessarily of the same type. In communication (especially, in telecommunications) and information processing: **encoding** is the process by which information is converted into symbols (usually belonging to an →*alphabet*) being communicated, stored or processed; whereas **decoding** is the reverse process which reconverts code symbols into information understandable or useful to the receiver (→*encoder and decoder*)

Notice that from this point of view the code is supposed to be simultaneously known by the sender (or source) and the receiver (or destination), which explains the inter-comprehension between them (in case it involves intention) or interoperability (if the information is understood only at a pragmatic or operational level). Therefore, this point of view deals with a traditional relation to →*reversibility*, which would explain neither the emergence nor the dynamics of code. An improvement of this perspective can be found in Foerster's criticism of cybernetics of the first order, which is intended to be improved in cybernetics of the second order as means of explaining self-referential and autopoietic processes (→*cybernetics, autopoiesis*; Foerster 1984).

In *semiotics*, a code -as system of signs- is a system of correlations or correlational rules between the coding system (system of signifiers or syntactic space or expression space) and a codified system (system of meanings or semantic space or content space). In words of Umberto Eco: the code "associates a vehicle-

of-the-sign (or signifier) with some-thing that is called its meaning or sense" (Eco 1973).

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(JMD)

COMMODIFICATION (S. *mercantilización,* F. *marchandisation,* G. *Ökonomisierung*) [political economy, moral] concept

On a general level the concept "commodification" (C) denotes the transformation of mere goods (use values) into "commodities" (German: "Waren") by selling and buying them on a market. Commodities carry both, use value and exchange value. As use values they are useful things for anybody (in any type of society) and represent concrete labour. As exchange values they embody a certain amount of abstract labour (in market economies only). C is closely related to the more general concept of "commercialization" (Z), which is not only true for physical or energetic objects, but also for services. The essential difference between C and Z is that only commodities contribute to the surplus product which is the basis for capital investment (on the physical level) and for surplus value (on the value level). Without surplus product in a closed economy there cannot be any profit.

Information societies are characterized by three new technologies, the computer, the Internet and Mobile Communication. The economically essential features are on the one hand that those technologies allow to reduce the transaction cost of business and private individuals (all activities of identification, re-trieval and exchange of information, coordination, and management). This enables new groups to enter business and markets and destroys others, but also empowers individuals to improve their organizational and networking competence. On the other hand, new digital technologies allow for the commercialization of more and more human activities (in particular cultural ones). While digital telephone services enable business to create new profitable markets and open up new spheres of investment, by a tricky interplay of Technology and the Law information goods can be transformed into new commodities. In the manner of a time machine Information Technology allows for freezing language, sound, movements (talking, singing, making music, dancing, writing etc.) on a carrier and for re-animating them at different points in time and space. In principle, Information and Communication Technology would also allow to copy the information and to distribute it on a global scale. There would be an abundance of information goods, because they do not disappear when they are consumed. But this would not be profitable. Therefore legal measures (Intellectual Property Rights) were creatively invented to secure markets of commodified information goods. By adding prices to information goods and services artificial shortage is created and can be directly and indirectly (by building up the infrastructure needed) exploited by private companies.

Lawrence Lessig (2004) rightly stresses that C and Z restrict the universal access to cultural products. Further cultural development and creativity could be severely hampered.

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(PF)

COMMUNICATION (S. *comunicación*, F. *communication*, G. *Kommunikation*, *Verbindung*, *Mitteilung*) [transdisciplinary] concept

Contents.— *1) Three dimensions of a complex phenomenon (a. the organizational dimension, b. the interactional dimension, c. the meaning dimension), 2) The 'informationalist' conception of communication, 3) The socio-cultural conception of communication.*

1. Three dimensions of a complex phenomenon.
It is possible to weave, from the perspective of complexity, a continuity line among the three epistemological dimensions of communication: organizational dimension, interactional dimension and meaning dimension.

a) The organizational dimension. Communication and information enter the heart of contemporary epistemology together with Shannon and Weaver's Mathematical Theory of Communication, von Bertalanffy's General Systems Theory and Wiener's Cybernetics. The organizational and adaptive dimension of the concept of communication is posed by Norbert Wiener as follows:

"Information is a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it. The process of receiving and of using information is the process of our adjusting to the contingencies of the outer environment, and of our living effectively within that environment. To live effectively is to live with adequate information. Thus, communication and control belong to the essence of man's inner life, even as they belong to his life in society" (Wiener, *Cybernetics and Society*, 1954:18)

Information is that way linked to the idea of order (in the sense of organizational regularities) as well as conceived as a product of that very organizational order. If information is the *matter* of complex organizational logics, communication is then the process par excellence of that same organizational dynamics. That very concept of information, as well as the organizational relevance of communication pro-

cesses, supports the foundations of the interactional dimension of information and communication, which in turn makes possible their role in the meaning sphere.

b) The interactional dimension. To exist, for a living being, is to be related to somebody. No living organism can develop efficiently far from 'the others', to such an extent, that the net of relations between an organism and its environment, between an organism and other organisms, becomes a prerequisite for life. That relational condition is shared by every living thing, not only by human beings. On the basis of its organizational condition, and as far as any living organization is a refined example of a complex organization, communication comes to be the interactional logics among living beings.

It is necessary, however, to distinguish between the conception of communication as interactional logics among living beings (behavioural coordination) and that of communication as a meaning practice. While certain consensus around 'behavioural ecology' can be observed in the first conception, there is no clear consensus in the latter. Thus, for instance, Pradier (1985) and Mac Roberts (1980) emphasize the need of intentionality as requirement for referring to communication in a natural sense. To some extent, these and other authors presume self-consciousness as a communicational prerequisite which, in the end, restricts communication to the human domain. They obviate, in that perspective, those contributions from ethology (Lorenz, 1972; Tinbergen, 1979; y von Frisch, 1957) and zoo-semiotics (Sebeok, 1972), which point, in one way or another, to an evolutionary line between communication in the biological sense and communication in those meaning oriented interactions that characterize humans.

From a different point of view, and keeping a convenient distance from Neo-Darwinian socio-biological assumptions, the Chilean biologists Maturana and Varela (1996) depart from the biological basis of the social phenomenon

to depict communication as a kind of recursive behaviour: communication is a behaviour specialised in behavioural coordination. Precisely due to that condition of being a behaviour that coordinates behaviours, the above mentioned authors state that any social form (human or not) is based on communicative behaviour, since behavioural coordination comes to be the phenomenic expression and the prerequisite of society.

c) The meaning dimension. The conceptual frame of Symbolic Interactionism constitutes the point of departure for the evolutionary change of constructivism: from epistemological and psychological constructivism to social constructivism. That process is marked by the contributions of Palo Alto Group (Watzlawick et alt., 1981), Goffman's interactional microsociology (Goffman, 1970) and Garfinkel's Ethnomethodology (Garfinkel, 1967). That constructivist current of sociological thought progressively moves its focus from cognitive processes to the symbolic processes, and lies at the base of those communication studies posing an alternative to the 'black box' paradigms (which obviate the observation of mind-behaviour and society-action correlations).

Especially, George Herbert Mead posed the interactional perspective as a critical answer to behaviourism and its stimulus-response model, putting the stress in the relevance of individual's internal experience and in the symbolic nature of inter-individual interactions. The influence of Mead's view can be even tracked in Habermas' Theory of Communicative Action (1987) and in Berger and Luckmann's phenomenological-constructivist thesis on the social construction of reality (1979).

In his well known *Mind, Self and Society* (1970), Mead posed a theory for the social constitution of the self as a sphere where the individual develops self-consciousness on the basis of his or her capacity to adopt the other's point of view. That kind of externalized reflexivity

would be the process through which the socially conscious self emerges.

Since communication constitutes the sphere where interactions –which constructivism deals with at the epistemological level- take place, Meads' idea takes communication as the prerequisite for human being both in its individual and social dimension. In addition, by conceiving those internal processes (obviated by behaviourism under the black box paradigm) as intrinsically social, Mead's theory becomes the driving force for all those perspectives focusing attention on subjects and processes, in opposition to those views which -like functionalism- emphasize structures and normative regularities.

Assuming Mead's proposal on communication as the core principle for both societal and individual constitution, Habermas (1987:134) develops his foundation of sociological thought in the terms of a theory of communication. From Mead on (together with the contributions of the Linguistic Turn in philosophy), thinking the human subject becomes thinking inter-subjective communication. The process of objectivizing the self that symbolic interactionism elucidates comes to be in this sense a socio-linguistic version of the epistemological reflection on the nature of the observer.

Together with the interactional conception, how the bond between the individual and the social system is conceived also changes. None of them can be thought of as external to each other, since it is language, cognitive patterns, rules and values of community the point of reference for the subject to give sense to any action. In its turn, social action has a sense which is simultaneously 'subjective' (the attributed sense) and 'objective', reified, externalized in the expressions, patterns and norms of relations. Thus, to understand how a subject builds an image of the self involves (in the perspective of social relations but also in the perspective of language use) his or her interactions with others, as well as the meaning and

value systems and the rules that organize behaviours and relations.

2. The 'informationalist' conception of communication. On the basis of the symbolic conception of communication and under the powerful influence of Shannon and Weaver's model, the process of human communication is generally defined as a kind of symbolic action in which an emitter (or *sender*) intentionally decides to start the process of sending a →*message* to a receiver through a →*communication channel* in order to express a given meaning. The emitter codifies the meaning via symbols, →*signs* or concrete representations, which may be verbal or non verbal, and are attached to common interpretations the receptor also knows (→*code*). The *receiver* receives and identifies the signals, and using his or her knowledge of attributed conventional meanings, the receiver changes his or her attitudinal behaviour.

In that process both emitter and receiver constantly and simultaneously exchange their roles, using a wide variety of variables from the context that make possible an appropriate interpretation of the message. Communicative processes are, in this view, essentially transactional, simultaneous and interactive. Both the emitter and the receiver are involved in a process of mutual cooperation in the construction of the message.

In any case, cognitive, psychological, social or cultural interferences can often affect the correct interpretation of the message by the recipient. Nevertheless, the absolute coincidence is usually not a requirement to produce communication. Generally, we manage to exchange information although the level of accuracy in the interpretation is not complete.

In case of interpersonal communication, the problem of semantic perception is usually counterbalanced by means of receiver's ability to answer (→*feedback*), and emitter's ability to put him/herself in the place of the recep (role-taking function). Both functions help to avoid -as far as possible- the semantic gap between emitter and receiver. The receiver can show the emitter, through verbal and non verbal signals, how he or she interprets the message. And the emitter can adjust his or her message taking the place of the receiver, thus facilitating that receiver's interpretation adapts to the preferred original meaning. In the role taking function, the emitter imagines the message from the receiver's viewpoint, considering if the receiver will be able to understand it as it will be intendedly formulated, or if some modification is instead required.

3. The socio-cultural conception of communication. Up to now we have characterized communication as a kind of information transmission. That idea of communication as information transmission has been the dominant model for theoretical considerations on the communicative actions. However, communication is related also to other functions. Some authors (Carey, 1989; Van Zoonen, 1994; Radford 2005) underline that the term communication (Lat. *Communicatio*) is related to communion, having in common, sharing, and participating. From this viewpoint, communication shows a clear socializing function, since it contributes to building and developing community through shared rituals, narratives, beliefs and values.

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(JMA –ed.-; JMA, LS)

COMMUNICATION CHANNEL (S. *canal de comunicación*, F. *canal de communications*, G. *Kommunikationskanal*) [transdisciplinary, MTC, channel theory, situation theory] concept

Contents.— *1) In Mathematical Theory of Communication, 2) In Channel theory*

1. In Mathematical Theory of Communication. In the MTC and many other information and communication theories by extension, C.C. deals with the medium (or set of media) that allow(s) transmitting the signals generated by the transmitter to the receiver. As stated by Shannon: "merely the medium used to transmit the signal from transmitter to receiver. It may be a pair of wires, a coaxial cable, a band of radio frequencies, a beam of light, etc".

It could be said that the objective of the transmission codifier is to adapt the messages, sent through the information source, to the characteristics of the channel (which has certain limitations and available resources, such as the bandwidth or frequency margin that can be sent). In the analysis, Shannon distinguishes between channels without noise (which is nothing but a theoretical abstraction that can approximately correspond to a situation in which the noise is negligible with respect to the received signals) and channels with noise (which is the normal situation and must especially be taken into consideration when the noise is notably present with respect to the signal).

A fundamental part of Shannon's theory is aimed at finding the limits of the →information amount that can be sent to a channel with given resources (→*Shannon's fundamental theorems*).

2. In Channel Theory. In →*channel theory* a *channel* sets up an informative relation between two situations. The fact that a channel relates two situations, s_1 and s_2, is formally denoted as:

$$s_1 \overset{c}{\Rightarrow} s_2$$

Which means that the situation s_1 contains information about the situation s_2, given the existence of channel c.

The regularities of higher order, discriminated and individualised by an agent for a given situation, constitute a type: the →*information flow* is caused by the existence of a type T supported by situation s_1 ($s_1 \sqsubset T$) transmitting information about another type T' supported by situation s_2 ($s_2 \sqsubset T'$). In this schema, situations s_1 and s_2 are respectively named *signal situation* and *target situation* with respect to c.

In formal terms, a channel c supports a constraint between types T and T', supported by both signal and target situations:

$$c \sqsubset T \rightarrow T'$$

if and only if for all situations s_1 and s_2, when $s_1 \sqsubset T$ and $T \rightarrow T'$ then $s_2 \sqsubset T'$.

In other words, if the situation s_1 supports type T, and there is a channel c between s_1 and s_2 supporting the constraint between two types of the respective situations ($c \models T \rightarrow T'$), then situation s_2 supports type T'.

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(JMD –ed.-; JMD, CA)

CONTENT (S. *Contenido*, F. *Contenu*, G. Inhalt) [semantics, mind] concept

In many contexts, the term "content" is synonymous with "meaning". There is content where it is possible to make semantic evaluations consisting in the attribution of properties like reference, connotation, sense, truth, etc. The three sorts of entities with the capacity to have content are certain mental states (beliefs, desires, intentions, decisions, etc.), linguistic entities (words, sentences, texts, etc.), and actions (and their results). In addition, a very important and widespread thesis, due to Paul Grice, is that linguistic entities and actions have content only because they are the outcome of certain mental states having content.

There is however another sense of the term "content" when it is applied to mental states. According to that second sense, mental states could have two different kinds of contents. They could have a conceptual content or a non-conceptual one. Non-conceptual content would be the experiential, qualitative or phenomenological content present in some mental states like sensations, feelings, emotions, etc. It would consist in a special way of experiencing the world and ourselves.

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(ML)

CONTEXT (S. *contexto*, F. *fr*, G. *al*) [transdisciplinary, communication theory] concept

"Context" stems from the Latin verb "contextere", meaning 'to weave' or 'to interlace'. In a figurative sense, it refers to the interlacing of the meanings contained in a text or, generally, in a communication, as well as in the circumstance in which this communication occurs (e.g. physical, pragmatic and cultural environment). It is this interlacing which enables specifying the meaning of what is intended to communicate. Although the meaning of 'context' in relation to statements is common, it is also applicable to the structure in which something is located, and without which it would be unintelligible or less intelligible.

A distinction can be made between *situational* context (or non-expressive context) and *expressive* context, in reference to the set of syntactically and semantically related expressions, which, at the same time, are articulated through deixis and modal indicators in the situational context. Furthermore, the situational context can be divided into: *general* (related to the communicational situation defined by the time, place and action within which the com-

munication is framed), *social* and *personal* (defined by the relationship between the communicants in their social interaction, their attitudes, interests and their respective knowledge).

There is a great disparity in the analysis of context from the different notions of information: from complete oblivion (in the most objectivisable meanings of information, according to which information is entirely contained within the message) to central attention (in those perspectives for which information makes only sense in social frameworks or in the adaptation to the environment, and where the message is often regarded as a key to release the information contained in the context). It is ironic that, while in linguistics the importance of context was highlighted, and in physics the classical conception of the outside observer was lost, at the same time Shannon's *Mathematical Theory of Communication* defined information as a typical characteristic of the information source without referring to its context. Something similar can be said concerning the origins of the *cognitive sciences* in the 1956 Symposium on Information Theory, where the consideration of cultural and historical contexts in which cognitive processes are immersed was minimized. However, although we might speak about epistemological anachronism, it also has to be acknowledged that the discussion about the hidden variables in quantum theory was alive, and the project on the unification of sciences of the Vienna circle was still running; on the other hand, the so-called historicist turn, which would underline the importance of cultural contexts, was still far away.

Nevertheless, in the field of →*cybernetics*, the contextualization of information has been an intrinsic aspect of its theory from the very beginning, since it is in the pragmatic situation (in which the environment is involved) that information gains meaning as a fundamental means to pursue an objective. Even so, it is cybernetics of the second order that will stress its demand with regard to contextualisation,

because, in order to survive, it is the regulatory structure of the system (underpinning purpose orientation) which depends on the eventual changes in the environment.

Likewise from the *quantum physics* point of view, information is –as stated by Mahler– a "contextual concept", intrinsically linked to a "situation". This situation is the dynamic scenario where an interacting system makes "decisions", leading to a proper "information flow". Therefore, in accordance with current physics, it cannot be said that information is encoded or conveyed in physical, elementary components; instead, it only appears after measuring. (v. Mahler 1996).

From the analysis of the *semantic* aspects of information there has also been a change towards a stronger concern on contexts: from the "ideal receiver" of Bar-Hillel and Carnap (1952), capable of assessing information in terms of a structure of atomic statements (in an almost formalised language), to the situational semantics of Barwise, Perry, Israel... (1980s and 1990s) in which information is not anymore conceived as a property of events but something essentially dependent on the context and the consistency restrictions between statements (→*informational content*). Here, it is also worth pointing out the proposal of Dretske that considers information in relation to a knowledge background and the proposal of Floridi basing information not on truth (as Dretske or the situationalists do, involving, in a certain way, a privileged view beyond any context), but on veracity, which entails the fallibility of the interpreter and the belonging to a temporality and a finite knowledge (Floridi 2005).

Although, as stated above, many of the information theories related to cognitive sciences show a reducing tendency to minimise the role of context, in other fields of social science, a number of approaches stressing context as an essential element have arisen. Thus, while under the cognitive interpretation the subject extracts information from the physical-chemical

properties of the sensory stimuli, in the hermeneutic, historical, critical-sociological and Luhmannian approach, the reference and meaning only appear contextualised in a cultural world.

In →*hermeneutics*, understanding is seen as something determined by schemas of pre-understanding determined by the cultural context of the interpreter. In the historical approximations, information acquires the level of genuine historical phenomena (Brown & Duguin 2000, Borgman 1999) or endowed with an essential temporality, which is also concluded from strictly physical assumptions (Matsuno 2000, Lyre 2002).

In Luhmann's →*system* theory, there is not properly a transmission of information. Instead of a direct conveying process, the emitter limits him/herself to making a suggestion for the selection within the "offer of meanings" (Mitteilung), which defines a communication process in a specific, socio-linguistic scenario (Luhmann 1987). However, in Habermas' critical sociology, the subject (or receiver) –although framed closer to a specific life horizon– has a reflexive faculty (or communicative competence, attained by virtue of being part of a certain social group). Such reflexivity eventually allows him/her to show the distortions, irregularities and censures that conditioning all factual communication processes (Habermas 1981). Hence we might say: Habermas' contextual interpretation of information enables going beyond Luhmann's "offer of meaning" or to move –by means of will-power– the hermeneutic life horizon.

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(JMD)

CONTRADICTION (S. *contradicción*, F. *contradiction*, G. *Widerspruch*) [transdisciplinary, logics, semantics, critical theory] concept

Relationship between an affirmation and a negation having the same subject and predicate. It was traditionally studied under the "law of non-contradiction" and initially formulated and studied by Aristotle as a supreme principle of beings and thinking. It can be formulated as:

'the same attribute cannot *at the same time* belong and not belong to the same subject and *in the same respect*.' (Aristotle, Metaph. B.IV, §3)

It has adopted a twofold interpretation distinguished by either a logical or an ontological sense, even erecting as an ontological principle, i.e. as expression of the constituting structure of reality. However, its fall as unquestionable principle can be found in Hegel's regard of contradiction as a basis of reality's internal movement (though generally the philosopher refers more to opposing realities than contradicting ones) (Hegel 1841). Within the dialectic tradition of Hegelian roots, Adorno judges that there exists a link between the ontological and logical aspects (Adorno 1966). According to such link the "repressive structure of reality" and the coercive character of survival as

well are reflected in the logical principle of contradiction (1956). Regarding Adorno's negative dialectics, the possibility of transcending both the law of non-contradiction and the law of identity accounts for the capacity to overcome social contradictions. Generally according to dialectical schools, the consideration of the logical law is just subordinate to the need of overcoming contradictions of reality.

This –so to speak– utilitarian regard (genetic, following Adorno's interpretation) of the law of non-contradiction can also be found in some of the information theories based on *self-referential* systems (→*autopoiesis*). For instance, from a *cybernetic* perspective, the logical law of non-contradiction can be considered as being a part of the regulation mechanism under normal conditions, whereas the overcoming of such law corresponds to the need of re-adapting the mentioned regulation to changing circumstances (s. *positive* and *negative* →*feedback*, →*cybernetics*).

Although the law of non-contradiction might be easily refuted in its most brief expression (removing the italic text in the above formulation, without which it might be exposed to a large number of paradoxes), it must be pointed out that the remark of *"at the same time and under the same respect"* makes it less vulnerable. This remark also introduces a necessary *contextualization* of the statements (to which we have referred to in the →*context* article) for a correct analysis of the consistency of the semantic content of information, such as the approaches of Bar-Hillel and Carnap (1953), Dretske (1982) and *Situation Theory* (Barwise 1997) propose –though only the last ones consider context as a key issue– (→*Situational logic*).

In any case, the claim to consistency in what is considered →*informational content* means that contradictions have no place in informational context and, consequently, the probability of receiving self-contradicting information would be zero (according to a naturalistic approach on information, such as the one of

Dretske, the ontological version of the law of non-contradiction states that contradictory information cannot emanate from reality, since reality itself rejects contradiction). Therefore, in case of considering the semantic content of an informative statement as inversely related to its probability –under Barwise's *inverse relationship principle* (1997)–, the following paradox might arise: a contradiction provides a maximum amount of information, which Floridi (2005c) labels as the *Bar-Hillel-Carnap Paradox*. Circumventing this paradox, most of semantic approaches get somehow rid of contradictions.

Nevertheless, if a dialectical point of view is adopted (for instance, in critical theory) contradictions will not be something for turning a deaf ear, but, on the contrary, the possibility of updating the view of reality with fewer contradictions. That is, contradictions might somehow announce –so to speak- a new world, a new Weltanschaung. If it could be achieved, a new state of affairs could be seen, whereas much of what was previously seen would dissolve with the smoke of past errors. For instance, the superseding of classical physics due to accretion of contradictions of different nature –optical, electrical, astronomical, etc– can be regarded as one of these cases (Pointcaré 1904). However, it must be remarked, on the one hand, that rarely the so-called contradictions follow the clause of *"at the same time and in the same respect"*, on the other hand, that in normal situations –or what Kuhn (1962) called, concerning research work, "normal science"– the contradictions serve to detect false information, wrong interpretations, etc. Thus the law of non-contradiction becomes an essential tool to receive information in normal situations, as well as for its incorporation into knowledge systems.

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(JMD)

CORRELATION (S. *correlación*, F. *corrélation*, G. *Korrelation*) [transdisciplinary, communication theory, situational theory, cognitive science] concept

There is a correlation between two factors when the presence of one makes the presence of the other vary with respect to the average situation.

We may obtain knowledge about the world inferring, from the occurrence of a fact (*the sign*), the occurrence of a different fact (*the signified*), based on the existence of a correlation between them. This correlation is supposed to hold given certain *local* conditions (Dretske's (1981) *channel conditions*). We then say that the occurrence of the sign carries *information* on the occurrence of the signified, or that it is a signal of this occurrence. Millikan (2004) calls this notion of information *local natural information*.

An obvious problem with it concerns the value of the conditional probability of the signified, given the sign. In his explanation of the notion, Dretske required that this probability be of 1, which, in most cases of transmission of information, has as a consequence the need for a theoretically dubious strengthening of the channel conditions. On the other hand, if one accepts that the conditional probability might be less than 1, not only a signal might occur without the occurrence of its signified (even with local conditions holding) —as when a beaver splashes the water with its tail in the absence of any real danger)— but we would be compelled to say, for instance, that the splashing of the water by the beaver informs its group of the presence of danger even if the corresponding conditional probability is low.

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(MC)

CRITICAL THEORY OF INFORMA-TION, COMMUNICATION, MEDIA AND TECHNOLOGY (S. *teoría crítica de la información, la comunicación, los medios y la tecnología*, F. *théorie critique de l'information, communication, media et technologie*, G. *Kritische Theorie der Information, Kommunication, Medien und Technologie*) [transdisciplinary, critical theory, information society, communication and media studies, ICT] theory

The notion of critical theory has a general and a specific meaning (Maces 2001: 74f, Payne 1997: 118). Critical theory as a general term means theories that are critical of capitalism and domination. Critical Theory as a more specific term means the work of the Frankfurt School, and particularly of Theodor W. Adorno, Max Horkheimer, Jürgen Habermas, and Herbert Marcuse. Its starting point is the work of Karl Marx (Held 1980: 15, Macey 2001: 75, Payne 1997: 118, Rush 2004: 9, Wiggershaus 1994: 5). For Horkheimer and his colleagues, critical theory "was a camouflage

label for 'Marxist theory'" (Wiggershaus 1994: 5) when they were in exile from the Nazis in the USA, where they were concerned about being exposed as communist thinkers and therefore took care in the categories they employed.

First, there are definitions of critical theory that remain very vague and general. So for example David Macey provides a definition that is circular, it defines critical by being critical without giving a further specification what it means to be critical. By critical theory he means "a whole range of theories which take a critical view of society and the human sciences or which seek to explain the emergence of their objects of knowledge" (Macey 2001: 74). Unspecific theories include those that do not define a certain normative project, but argue that critical theory is about political engagement or showing the difference between potentiality and actuality. So for example Michael Payne sees political engagement as the central characteristic of critical theory. He defines the latter as "research projects in the social sciences and/or humanities attempt to bring truth and political engagement into alignment" (Payne 1997: 118). Craig Calhoun focuses on defining critical theory as a project that shows the difference between potentiality and actuality and argues for potential futures: Critical social theory "exists largely to facilitate a constructive engagement with the social world that starts from the presumption that existing arrangements – including currently affirmed identities and differences – do not exhaust the range of possibilities. It seeks to explore the ways in which our categories of thought reduce our freedom by occluding recognition of what could be. (...) It helps practical actors deal with social change by helping them see beyond the immediacy of what is at any particular moment to conceptualize something of what could be. (...) By taking seriously the question of what it would mean to transcend the current epoch, critical theory opens more space for considering the possibility that the world could be different than it is than does any simple affirmation of

existing differences or claim that postmodernity is just a matter of perspective" (Calhoun 1995: xiv, 9, 290).

It is certainly true that critical theory focuses on society, wants to foster political engagement, and wants to show the difference between potentiality and actuality in society. But these specifications do not suffice for speaking of critical theory. Further characteristics need to be added in order to avoid for example that theories, which argue for right-wing extremist or nationalist goals, can be considered as critical.

Second, there are definitions that are so specific that they only consider one approach or a few approaches as critical theories and exclude other approaches. So for example Rainer Forst gives a definition of critical theory that is clearly focusing on a strictly Habermasian project. Critical theory would explain and question factors that constrain communication: "As normative theory, Critical Theory thus argues for the integrity of a sphere of communicative, normative integration as well as for the realization of the possibility of social and political discourse; as social-scientific theory, it explains the factors and structures that impair the communicative social infrastructure and that hinder discourse (e.g., by the exclusion of actors from political argumentation and decision making); and as participant in social struggles, it argues for those norms and institutions that can be defended to all those who are 'subjects' of these norms and institutions" (Forst 1999: 143).

Axel Honneth puts two concepts at the heart of critical theory, disrespect and malrecognition. He sees critical theory as an analysis of structures that cause disrespect and malrecognition:

Critical Theory analyzes "social relations of communication (...) primarily in terms of the structural forms of disrespect they generate", it focuses on "the damage and distortion of social relations of recognition" (Honneth

2007: 72). Honneth says that all Critical Theorists share the assumption that "the process of social rationalization through the societal structure unique to capitalism has become interrupted or distorted in a way that makes pathologies that accompany the loss of a rational universal unavoidable" (Honneth 2004: 349).

So on the one hand, if one defines critical theory in very broad sense, then the normative aspect of critical theory as critique of domination becomes lost. On the other hand, if one defines critical theory in a very strict sense focusing on specific theories, scholars, or single concepts, then one risks advancing a narrow-minded definition that weakens the academic and political power of critical theory by isolating approaches.

A third way of defining critical theory is to see it as analysis and questioning of domination, inequality, societal problems, exploitation in order to advance social struggles and the liberation from domination so that a dominationless, co-operative, participatory society can emerge. Some examples of such definitions can be given:

Fred Rush sees critical theory as the analysis of domination and inequality for fostering social change: "It is an account of the social forces of domination that takes its theoretical activity to be practically connected to the object of its study. In other words, Critical Theory is not merely descriptive, it is a way to instigate social change by providing knowledge of the forces of social inequality that can, in turn, inform political action aimed at emancipation (or at least at diminishing domination and inequality)" (Rush 2004: 9).

David Held argues that the critical theorists Adorno, Habermas, Horkheimer, and Marcuse have aimed at establishing a free society and at exposing the obstacles for this development: "Following Marx, they were preoccupied, especially in their early work, with the forces which moved (and might be guided to move) society towards rational institutions – institutions which would ensure a true, free

and just life. But they were aware of the many obstacles to radical change and sought to analyse and expose these. They were thus concerned both with interpretation and transformation" (Held 1980: 15).

Douglas Kellner defines critical theory as a project that confronts societal problems and domination and seeks liberation from these conditions: "Critical Theory is informed by multidisciplinary research, combined with the attempt to construct a systematic, comprehensive social theory that can confront the key social and political problems of the day. The work of the Critical Theorists provides criticisms and alternatives to traditional, or mainstream, social theory, philosophy and science, together with a critique of a full range of ideologies from mass culture to religion. At least some versions of Critical Theory are motivated by an interest in relating theory to politics and an interest in the emancipation of those who are oppressed and dominated. Critical Theory is thus informed by a critique of domination and a theory of liberation" (Kellner 1989: 1).

Alvesson and Deetz define critical studies as the disruption of domination that provides impulses for liberation from it: "Critical research generally aims to disrupt ongoing social reality for the sake of providing impulses to the liberation from or resistance to what dominates and leads to constraints in human decision making. (...) Critique here refers to the examination of social institutions, ideologies, discourses (ways of constructing and reasoning about the world through the use of a particular language) and forms of consciousness in terms of representation and domination. Critique explores if and how these constrain human imagination, autonomy, and decision making. Attention is paid to asymmetrical relations of power, taken for granted assumptions and beliefs. (...)" (Alvesson and Deetz 2000: 1, 8f).

Karl Marx provided a definition of critique that allows us to define critical theory not just as critique and analysis of capitalism, but of

domination in general. Critical information theory as critique of domination in the context of media, culture, and communication correspond perfectly to the understanding of critique given by Marx in the Introduction to the Critique of Hegel's Philosophy of Right in 1844: "Theory is capable of gripping the masses as soon as it demonstrates ad hominem, and it demonstrates ad hominem as soon as it becomes radical. To be radical is to grasp the root of the matter. But, for man, the root is man himself. (...) The criticism of religion ends with the teaching that man is the highest essence for man – hence, with the categoric imperative to overthrow all relations in which man is a debased, enslaved, abandoned, despicable essence, relations which cannot be better described than by the cry of a Frenchman when it was planned to introduce a tax on dogs: Poor dogs! They want to treat you as human beings!" (MEW 1: 385).

If we conceive ontology as the philosophical question about being (What exists?), epistemology as the philosophical question about the cognition of being (How do we conceive and perceive reality?), and axiology as the philosophical question about human praxis as the consequence of the cognition of being (What form of existence is desirable for humans?), then we can say that an academic field has three dimensions. Based on this insight and on Marx's notion of critique, we can identify three important elements of critical theory:

1) **Epistemology – Dialectical Realism**: Realism assumes that a world exists that is larger than the human being and its imaginations. The material world is seen as primary and it is assumed that humans are able to grasp, describe, analyze, and partly transform this world in academic work. Analyses are conducted that are looking for the essence of societal existence by identifying contradictions that lie at the heart of development. Critical theory analyzes social phenomena not based on instrumental reason and one-dimensional logic, i.e. it operates: 1. With the assumption that phenomena do

not have linear causes and effects, but are contradictory, open, dynamic, and carry certain development potentials in them and hence should be conceived in complex forms; 2. Based on the insight that reality should be conceived so that there are neither only opportunities nor only risks inherent in social phenomena, but contradictory tendencies that pose both positive and negative potentials at the same time that are realized or suppressed by human social practice.

Dialectic analysis in this context means complex dynamic thinking, realism an analysis of real possibilities and a dialectic of pessimism and optimism. In a dialectical analysis, phenomena are analyzed in terms of the dialectics of agency and structures, discontinuity and continuity, the one and the many, potentiality and actuality, global and local, virtual and real, optimism and pessimism, essence and existence, immanence and transcendence, etc. Such an analysis assumes that the world is not as it is presented to us, but that there is a larger essence underlying existing phenomena.

2) **Ontology – Dynamic Materialism**: Critical theory is materialistic in the sense that it addresses phenomena and problems not in terms of absolute ideas and predetermined societal development, but in terms of resource distribution and social struggles. Reality is seen in terms that address ownership, private property, resource distribution, social struggles, power, resource control, exploitation, and domination.

To make a materialistic analysis also means to conceive society as an interconnected whole (totality) and as negativity, to identify antagonisms means to take a look at contradictory tendencies that relate to one and the same phenomenon, create societal problems and require a fundamental systemic change in order to be dissolved. To analyze society as contradictory also means to con-

sider it as dynamic system because contradictions cause development and movement of matter.

In order to address the negativity of contemporary society and its potential, research also needs to be oriented on the totality. That dialectics is a philosophy of totality in this context means that society is analyzed on a macro-scale in order to grasp its problems and that reasons for the necessity of positive transformations are to be given.

3) **Axiology – Negating the negative**: All critical approaches in one or the other respect take the standpoint of oppressed or exploited classes and individuals and make the judgement that structures of oppression and exploitation benefit certain classes at the expense of others and hence should be radically transformed by social struggles. This view constitutes a form of normativity.

Critical theory does not accept existing social structures as they are, it is not purely focused society as it is, but interested in what it could be and could become. It deconstructs ideologies that claim that something cannot be changed and shows potential counter-tendencies and alternative modes of development. That the negative antagonisms are sublated into positive results is not an automatism, but depends on the realization of practical forces of change that have a potential to rise from the inside of the systems in question in order to produce a transcendental outside that becomes a new whole. The axiological dimension of critique is an interface between theory and political praxis. It is based on the categoric judgement that a participatory, co-operative society is desirable.

Critical theory is a transdisciplinary project that at the epistemological level employs methods and theoretical categories that are employed for describing reality as dialectical contradictory field that poses risks and opportunities so that at the ontological level reality is grasped in terms that address ownership,

private property, resource distribution, social struggles, power, resource control, exploitation, and domination so that at the axiological level dominative structures are judged as being undesirable and potential ways for alleviating suffering and establishing a co-operative, participatory society are identified that can enter as impulses into into political struggles and political transformations of society.

Two central texts of Critical Theory, Horkheimer's Traditional and Critical Theory and Marcuse's Philosophy and Critical Theory, can be interpreted for not being constitutive for Frankfurt School Critical Theory, but for critical theory in general. In these works, Horkheiemr and Marcuse on the one hand stress the limits and one-dimensionality of positivism that they consider as stabilizing forces that neglect potential alternatives to capitalism in their analyses. On the other hand, the most important uniting feature of the two works that makes them grounding works for critical theory in general is the axiological questioning of domination and the focus on the necessity of the establishment of a non-dominative society.

For Horkheimer, the goal of critical theory is the improvement of society: "In the interest of a rationally organized future society", critical theory sheds "critical light on present-day society (…) under the hope of radically improving human existence" (Horkheimer 1937: 233). He specifies this improvement as the right kind of society that in negative terms is non-exploitative: "The Marxist categories of class, exploitation, surplus value, profit, pauperization, and breakdown are elements in a conceptual whole, and the meaning of this whole is to be sought not in the preservation of contemporary society, but in its transformation into the right kind of society" (Horkheimer 1937: 218). Critical theory strives for "a state of affairs in which there will be no exploitation or oppression" (241), a "society without injustice" (221).

This emancipation in positive terms would bring happiness and self-determination for all:

"Its goal is man's emancipation from slavery" (249) and "the happiness of all individuals" (248). Critical theory advances "the idea of self-determination for the human race, that is the idea of a state of affairs in which man's actions no longer flow from a mechanism but from his own decision" (Horkheimer 1937: 229). Such a society is shaped by "reasonableness, and striving for peace, freedom, and happiness" (222) and the "the establishment of justice among men" (243). Mankind will then become conscious of its existence: "In the transition from the present form of society to a future one mankind will for the first time be a conscious subject and actively determine its own way of life" (233). Political transformation is a process of negation, the corresponding theoretical procedure in critical theory is the method of negation: "The method of negation, the denunciation of everything that mutilates mankind and impedes its free development, rests on confidence in man" (Horkheimer 1947/1974: 126)

For Marcuse, critical theory is oriented against the negative totality of capitalism: "Marx's theory is a 'critique' in the sense that all concepts are an indictment of the totality of the existing order" (Marcuse 1941a: 258). In turning negativity into a potential positive result, Marcuse (1937: 135) says that critical theory is concerned "with human happiness, and the conviction that it can be attained only through a transformation of the material conditions of existence" is a central element of critical theory. Its goals is "the creation of a social organization in which individuals can collectively regulate their lives in accordance with their needs" (Marcuse 1937: 141f), a societal condition, in which we find "the subordination of the economy to the individuals' needs" (Marcuse 1937: 144). It struggles for universal freedom and can therefore be considered as a universalistic theory. It claims that "all, and not merely this ort hat particular person, should be rational, free, and happy. (...) Critical theory's interest in the liberation of mankind binds it to certain ancient truths. It is at one with philosophy in maintaining that man can be more

than a manipulable subject in the production process of class society" (Marcuse 1937: 152f). Critical theory's task is "to demonstrate this possibility and lay the foundation for a transformation" (Marcuse 1937: 142). It wants to bring "to consciousness potentialities that have emerged within the maturing historical situation"(Marcuse 1937: 158).

If we assume that information, media, communication, culture, and technology play an important role in contemporary capitalism, then the critique of these phenomena in contemporary society becomes one of the tasks of a critical theory of society. A critical theory of information, communication, and media therefore is a sub-domain of a contemporary critical theory of society.

Based on the general notion of critical theory that has already been outlined, we can from a praxeo-onto-epistemological perspective on science (See Hofkirchner, Fuchs and Klauninger 2005: 78-81) define critical studies of information, communication, and media as studies that focus ontologically on the analysis of information, media, communication, culture, technology in the context of domination, asymmetrical power relations, exploitation, oppression, and control by employing at the epistemological level all theoretical and/or empirical means that are necessary for doing so in order to contribute at the praxeological level to the establishment of a participatory, co-operative society. Given such a definition, critical communication and media studies are inherently normative and political.

This definition is fairly broad and allows to combine different concepts that come from different critical backgrounds, such as for example – to name just some of many – audience commodity, media accumulation strategies, commodity aesthetics, culture industry, true and false consciousness/needs, instrumental reason, technological rationality, manipulation, ideology critique, dialectical theatre, critical pedagogy, aura, proletarian counter-public sphere, multiple publics, emancipatory media

usage, repressive media usage, alternative media, radical media, fetish of communication, ideological state apparatuses, the multitude, the circulation of struggles, hegemony, structure of feelings, articulation, dominant reading, oppositional reading, negotiated reading, capital-accumulation function of the media, commodity circulation function of the media, legitimatizing function of the media, advertising- and public-relations function of the media, regenerative function of the media, propaganda model of the media, communicative action, dialogic communication, discursive communication, communication empire, transnational informational capitalism, working class culture, subculture, etc, under one united umbrella definition that sees them as differentiated unity in plurality that is termed critical information, communication, and media studies.

Critical studies of information, media, and communication should be embedded into a broader social science perspective in order to show which position they occupy in the overall field of the social sciences. They should therefore be connected to social theory and social theory typologies.

Anthony Giddens sees the "division between objectivism and subjectivism" (Giddens 1984, xx) as one of the central issues of social theory. Subjective approaches are oriented on human agents and their practices as primary object of analysis, objective approaches on social structures. Structures in this respect are institutionalized relationships that are stabilized across time and space (Giddens 1984, xxxi). Integrative social theories (such as the ones by Roy Bhaskar (1993), Pierre Bourdieu (1986), Anthony Giddens (1984), or Margaret Archer (1995)) aim at overcoming the structure-agency divide.

Burrell and Morgan (1979) have combined the distinction between subject and object with the distinction between continuity and discontinuity in order two identify two axes that set up two dimensions so that four different approaches can be identified in social theory:

radical humanism (subjective, radical change), radical structuralism (objective, radical change), interpretive sociology (subjective, continuity), and functionalism (objective, continuity).

Figure 1: Four paradigms of social theory identified by Burrell and Morgan (1979)

The problem with this approach is that in contemporary social theory there are approaches that cross the boundaries between the four fields and that the four paradigms therefore can no longer be strictly separated. The distinction continuity/discontinuity remains valid in political terms. So for example the approaches by Roy Bhaskar (1993), Pierre Bourdieu (1986), Anthony Giddens (1984), and Margaret Archer (1995) have in common that they are based on a dialectical subject-object-integration, but Bhaskar and Bourdieu are overall critical of class society that they want to abolish, whereas Giddens and Archer want to transform modernity, but overall aim at its continuation. The approaches by Bhaskar and Bourdieu could therefore be described as integrative-radical change, the ones by Giddens and Archer as integrative-continuous. This requires certain changes to the typology of Burrell and Morgan that are shown in Figure 2.

Figure 2: A refined version of Burrell's and Morgan's typology

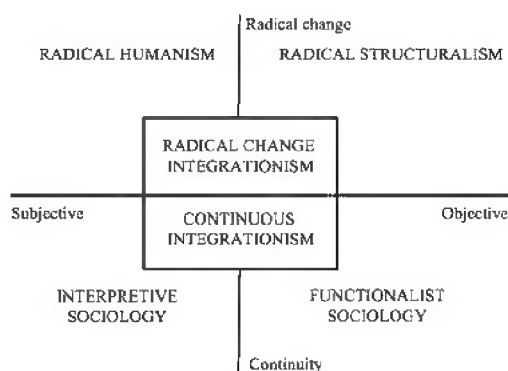A number of communication scholars have stressed that it makes sense to use the typology by Burrell and Morgan for identifying different approaches in communication studies and communication theory (Deetz 1994, McQuail 2002, Rosengren 1993, 2000). "This scheme is equally helpful in mapping out the main alternative approaches to media theory and research, which have been seriously divided by their chosen methodologies and priorities, as well as by their degree of commitment to radical change" (McQuail 2002: 5). "It is highly relevant when trying to understand different traditions within the study of communication" (Rosengren 2000: 7).

Robert T. Craig (1999) has identified seven traditions of communication theory that are based on how they communication is defined (See table 1). Although his approach is very relevant and his paper (Craig 1999) has been one of the most frequently cited papers in communication studies in the past decade, he does not specify an underlying distinctive criterion for his typology, which gives it a rather arbitrary character. Therefore it makes sense to combine his seven traditions of communication theory with the refined version of Burrell's and Morgan's typology. The results are shown in figure 3.

Table 1: Typology of communication theories according to Craig (1999, 2007)

Type of approach:	Communication theorized as:	Subject/ object	Examples
Rhetorical	The practical art of discourse	Subjective	Aristotle, Lloyd F. Bitzer, Kenneth Burke, Thomas B. Farrell, Sonja Foss & Cindy Griffin, Stephen W. Littlejohn, Plato
Semiotic	Intersubjective mediation by signs	Objective	Roland Barthes, Wendy Leeds-Hurwitz, John Locke, Charles Morris, Charles Sanders Peirce, John Durham Peters, Ferdinand de Saussure
Phenome-nological	Experience of otherness; dialogue	Subjective	Martin Buber, Brinkle G. Chang, Hans-Georfg Gadamer, Edmund Husserl, Maurice Merleau-Ponty, Joseph J. Pilotta & Algis Mickunas, John Robert Stewart
Cybernetic	Information processing	Objective	Gregory Bateson, Annie Lang, Niklas Luhmann, Claude Shannon, Paul Watzlawick, Warren Weaver, Norbert Wiener
Sociopsychological	Expression, interaction, & influence behaviour in communication situations	Subjective	Albert Bandura, Charles R. Berger & Richard J. Calabrese, Carl Hovland, Marshall Scott Poole
Sociocultural	Symbolic process that reproduces shared sociocultural patterns	Objective	Peter L. Berger, Deborah Cameron, Thomas Luckmann, George Herbert Mead, Mark Poster, James R. Taylor
Critical	Discursive reflection	Subjective/ Objective	Theodor W. Adorno, Stanley A. Deetz, Jürgen Habermas, Max Horkheimer, Sue Curry Jansen

Figure 3 shows that critical communication studies are primarily characterized by their radical change perspective, i.e. the analysis of how communication contributes to domination and how ways can be found that communication can take place in a dominationless way within a participatory society. This also means that there are subjective, objective, and subject-object-dialectical approaches within critical communication studies. Craig mentions several boundary-crossing approaches that can be considered as representing attempts at combining some of the four fields in figure 3: Kennth Burke, David S. Kaufer and Kathleen M. Carley (Rhetoric-Semiotics); Briankle Chang, Richard L. Lanigan (Phenomenology-Semiotics), David S. Kaufer and Brian S. Butler (Cybernetics-Rhetoric), Klaus Krippendorff (Cybernetics-Phenomenology), John C. Heritage, Gerald T. Schoening and James A. Anderson (Sociocultural Studies-Phenomenology-Semiotics), W. Barnett Pearce (Sociocultural Studies-Rhetoric-Cybernetics), Rayme McKerrow (Critical Studies – Rhetoric), Robert Hodge and Gunter Kress, Norbert Fairclough (Critical Studies-Semiotics).
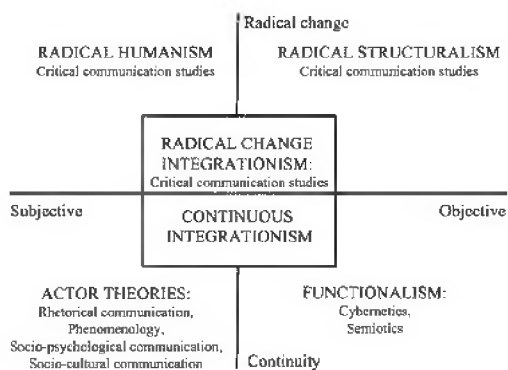

Figure 3: A typology of communication theories

For Craig, the characteristic that distinguishes critical communication studies from rhetorical, semiotic, phenomenological, cybernetic, sociopsychological, and sociocultural traditions of communication theory is that for "critical communication theory, the basic 'problem of communication' in society arises from material and ideological forces that preclude and distort discursive reflection. (..) Fundamentally, in the tradition of Marx, its point is not to understand the world (…) Its point is to change the world through praxis, or theoretically reflective social action" (Craig 1999, 147f). Craig works out the specifics of critical studies and other traditions in communication studies. However, I would add to Craig's account of critical communication studies that it is not only about the analysis of those conditions that distort communication, i.e. the ways how communication is embedded into relations of domination, but also about finding alternative conditions of society and communication that are non-dominative and about struggles for establishing such alternatives. Craig argues that "communication theory has not yet emerged as a coherent field study" and that this fragmentation can be overcome by constructing "a dialogical-dialectical disciplinary matrix" (Craig 1999, 120) that enables the emergence of a conversational community, "a common awareness of certain complementarities and tensions among different types of communication theory, so it is commonly understood that these different types of theory cannot legitimately develop in total isolation from each other but must engage each other in argument" (Craig 1999, 124). The same can be said about critical communication studies as a subfield of communication studies: A disciplinary matrix of critical communication studies can enhance the dialogue between various subfields of the subfield, such as critical theory-, critical political economy-, cultural studies-, feminist theory-, postcolonial theory-, queer theory-, new social movements-approaches in critical communication studies, so that common assumptions and differences about what it means to conduct critical studies of communication can emerge.

Fuchs (2010) identifies different types of critical media, information, and communication theories (See Table 2). Those approaches that see media, information, and communication primarily as embedded into repressive con-

texts, can be considered as more structuralistic-objectivistic approaches, they focus on how media structures negatively shape humans and society. Those approaches that see media, information, and communication primarily as potential forms of liberation can be considered as more humanistic-subjectivistic approaches, they focus on how media structures positively enable human participation and liberation. Integrative approaches try to blur the boundaries between subjective and objective theories.

Table 2: A typology of critical media theories

	Production Sphere	Circulation Sphere	Consumption
Repression Hypothesis	Commodity Hypothesis: Media as commodities for accumulating capital		
Repression Hypothesis		Manipulation- and Ideology Hypothesis: Media as means of manipulation for the ideological enforcement of class interests	
Emancipation Hypothesis	Alternative Media Hypothesis: Media as spheres of grassroots production and circulation of alternative content		Reception Hypothesis: Media reception as contradictory process involving oppositional practices
Unification	Integrative critical media theories		

Representatives of the commodity hypothesis argue that the media are not primarily ideological means of manipulation, but spheres of capital accumulation. The basic contention underlying the manipulation and ideology hypothesis is that the media are used as tools that manipulate people, advance ideologies, forestall societal transformations, create false consciousness, false needs, and a one-dimensional universe of thought, language, and action. Scholars who argue that there are alternative ways of doing and making media for critical ends and for fostering participatory media practices advance the alternative media hy-
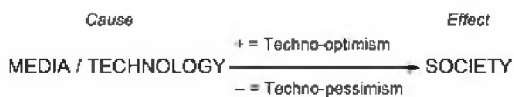
pothesis. Such approaches have a strong subjective orientation. Representatives of the reception hypothesis argue that reception is a complex and antagonistic process that provides potentials for oppositional interpretations and actions. The most prominent representatives of this hypothesis can be found in cultural studies. The shortcomings of existing critical approaches can be overcome by integrative dialectical critical media theories/studies that try to bring together some or all of the various levels of critical media studies. One can identify some existing approaches that point into this direction. Integration and unification does not mean that difference is abolished at the expense of identity. It rather means a Hegelian dialectical sublation (Aufhebung), in which old elements are preserved and elevated to a new level. New qualities emerge by the interaction of the moments. Such a dialectical integration is a differentiated unity that is based on the principle of unity in diversity. It is a dialectical relation of identity and difference. Fuchs (2010) mentions the following example theories for integrative critical media theories: Robert McChesney, Stuart Hall, Douglas Kellner, Shane Gunster, Vilém Flusser, Herbert Marcuse. These theories would bridge certain hypotheses of critical media and information studies to a greater or lesser degree, but an overall synthesis would still be missing.

One of the reasons why critical theory is important for analyzing media, technology, and information is that it allows to question and provide alternatives to technological determinism and to explain the causal relationship of media and technology on the one hand and society on the other hand in a balanced way that avoids one-dimensionality and one-sidedness. Technological determinism (See Figure 4) is a kind of explanation of the causal relationship of media/technology and society that assumes that a certain media or technology has exactly one specific effect on society and social systems. In case that this effect is assessed positively, we can speak of techno-optimism. In case that the effect is assessed negatively,

we can speak of techno-pessimism. Techno-optimism and techno-pessimism are the normative dimensions of technological determinism.

A critical theory of media and technology is based on dialectical reasoning. This allows to see the causal relationship of media/technology and society as multidimensional and complex: A specific media/technology has multiple, at least two, potential effects on society and social systems that can co-exist or stand in contradiction to each other. Which potentials are realized is based on how society, interests, power structures, and struggles shape the design and usage of technology in multiple ways that are also potentially contradictory.

Technological/Media determinism:
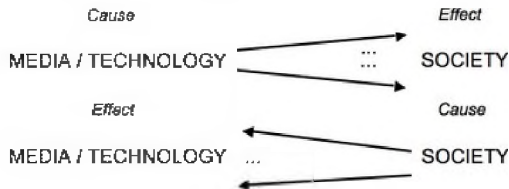

Dialectic of technology/media:

Figure 4: Technological/media determinism and dialectic of technology/media

Andrew Feenberg argues in his critical theory of technology that technology is an ambivalent process: "Critical theory argues that technology is not a thing in the ordinary sense of the term, but an 'ambivalent' process of development suspended between different possibilities. This ambivalence of technology is distinguished from neutrality by the role it attributes to social values in the design, and not merely the use of technical systems. On this view, technology is not a destiny but a scene of struggle. It is a social battlefield, or perhaps a better metaphor would be a 'parliament of things' in which civilizational alternatives contend. (…) Critical theory holds that there can

be at least two different modern civilizations based on different paths of technical development. (…) Technologies corresponding to different civilizations this coexist uneasily within our society" (Feenberg 2002: 15). "In sum, modern technology opens a space within which action can be functionalized in either one of two social systems, capitalism or socialism. It is an ambivalent or 'multistable' system that can be organized around at least two hegemonies, two poles of power between which it can 'tilt'" (Feenberg 2002: 87). "Technological development is overdetermined by both technical and social criteria of progress, and can therefore branch in any of several different directions depending on the prevailing hegemony. (…) While social institutions adapt to technological development, the process of adaptation is reciprocal, and technology changes in response to the conditions in which it finds itself as much as it influences them" (Feenberg 2002: 143). Feenberg says that the critical theory of technology is a dialectical theory of technology (Feenberg 2002: 176-183). Its goal is a transformation of technology from "reification to reintegration" (Feenberg 2002: 183).

Feenberg's critical theory questions technological determinism, which he defines as "the deterministic assumption that technology has its own autonomous logic of development. According to this view, technology is an invariant element that, once introduced, bends the recipient social system to its imperatives. (…) Determinism is based on the following two theses: 1. The pattern of technological progress is fixed, moving along one and the same track in all societies. Although political, cultural, and other factors may influence the pace of change, they cannot alter the general line of development that reflects the autonomous logic of discovery. 2. Social organization must adapt to technical progress at each stage of development according to 'imperative' requirements of technology. The adaptation executes an underlying technical necessity. (…) Technology appears to be an application of the laws

of nature to problems of production, as independent of human will as the movements of the heavenly bodies" (Feenberg 2002: 138f).

The dialectical critical theory of technology is grounded in the works of Karl Marx, who said that technology has contradictory potentials and that under capitalism the negative ones predominate: "The contradictions and antagonisms inseparable from the capitalist application of machinery do not exist, they say, because they do not arise out of machinery as such, but out of its capitalist applications! Therefore, since machinery in itself shortens the hours of labour, but when employed by capital it lengthens them; since in itself lightens labour, but when employed by capital it heightens its intensity; since in itself it is a victory of man over the forces of nature but in the hands of capital it makes man the slave of those forces; since in itself it increases the wealth of the bourgeois economist simply states that the contemplation of machinery in itself demonstrates with exactitude that all these evident contradictions are a mere semblance, present in everyday reality, but not existing in themselves, and therefore having no theoretical existence either. Thus her manages to avoid racking his brains any more, and in addition implies that his opponent is guilty of the stupidity of contending, not against the capitalist application of machinery, but against machinery itself" (Marx 1867: 568f). Also Herbert Marcuse is a representative of a dialectical critical theory of technology that identifies contradictory potentials of technology: "Technics by itself can promote authoritarianism as well as liberty, scarcity as well as abundance, the extension as well as the abolition of toil" (Marcuse 1941: 41).

In recent years, the possibility of combining critical theory and information science has been stressed (Day 2001, 2005, 2007, Fuchs 2008b). Ronald E. Day argues that information science has treated information mainly as a "reified and commoditized notion" (Day 2001: 120). "The unwillingness of research on information to actually attempt to situate a culture of information and communication in terms of interested and powerful social and historical forces is evident by even a brief glance at journals in information management or information studies or in policy papers. Coupled wit the dominant tendency of such research to be 'practical' in the service of professional and business organizations and in the service of military and industrial research projects, research in information simply shies away from critical engagement, as well as from foundational, qualitative, or materialist analyses, especially from that which is seen to employ 'pretentious', 'political', or, equally, 'foreign' vocabulary, let alone philosophical or Marxist analyses" (Day 2001: 116f). Day understands critical theory in a very general sense as "the deployment of concepts in critical and interruptive relation to the conceptual foundations of commonly accepted practices" (Day 2001: 116). The problem with such a contextual definition of critical theory is that it is purely contextual: In case that socialism becomes a commonly accepted practice, right wing extremist theory then becomes a "critical" theory. Therefore additional qualities for defining critical theory are needed. A critical theory of information for day examines information's "institutional, political, and social" context and its "reflexive relationships to material forces and productions" (Day 2001: 118). Day (2007) argues that Rob Kling on the one hand has defined Social Informatics as empirical research, which brings forward positivistic associations, but that on the other hand he tried to deconstruct technological determinism as ideology. Social informatics would therefore be "'critical' of the 'uncritical' discourses about the social values and uses of computers/IT/ICTs" (Day 2007: 578). He concludes that "the heart of Kling's conception of social informatics was a critical informatics, and that the cornerstone for critical informatics were approaches that remained a minority in Kling's overall work" (Day 2007: 582).

Ajit K. Pyati (2006) suggests that critical information studies should be based on a Marcusean infusion because his notion of technological rationality allows explaining why information is primarily treated as a commodity and thing in contemporary society and contemporary library and information studies. Marcuse's notion of one-dimensionality would allow deconstructing the neoliberal discourse that argues for the privatization and commodification of information and libraries as ideologies. "An information society that is associated with techno-capitalism, neo-liberalism, and ideologies of deregulation can ultimately undermine the basis of the public service mission of libraries. In a certain sense, libraries with public service mandates (particularly public and certain academic libraries) act in some degree as 'anti-capitalist spaces' and have the potential to reframe an information society in a more radically democratic, culturally inclusive, and progressive vision. (…) The discourse of ICTs does not have to necessarily be part of a free market, capitalist ideology, but can serve more radical democratic aims, particularly in democratizing access to information and knowledge. Libraries, in becoming active developers and shapers of ICTs for democratic and progressive ends, may help to combat some of the hegemony of the dominant information society" (Pyati 2006: 88).

Christian Fuchs (2008a, b, 2009) has argued that critical information studies should best be conceived within the framework of Marxian theory (i.e. the critique of the political economy, cp. also the "Cyber-Marx" approach by Nick Dyer-Witheford 1999) and a broad notion of a critical theory of media, information, communication, technology, and culture. The task is to analyse domination and capitalism as the context of information and media in contemporary society and to give intellectual impulses for finding alternative modes of information and media that work outside of capitalism and domination. Fuchs suggests that this approach allows constructing a critical theory of Internet/ICTs and society (Fuchs 2008a, 2009) and a critical theory of information (2009a). An objectivist notion of information is for Fuchs an ideology that drives the commodification of information. If information is seen as a thing, then it is obvious to argue that it should be treated as a commodity. But also subjectivistic notions of information are ideologies for Fuchs: If knowledge is considered as individual creation, then the call for intellectual property rights that make sure that knowledge is treated as commodity that is sold on markets in order to generate money profit, can easily be legitimated. In the end, subjectivist notions of information turn out to be ideologies that legitimate private property and the commodity form of information. The alternative is to consider information as a dialectical process that establishes an interconnection of subjects and objects via a threefold process of cognition, communication, and co-operation.

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(CF)

CYBERNETICS (S. *cibernética*, F. *cybernétique*, G. *Kybernetik*) [Interdisciplinary]discipline

"Cybernetics" stems from the Greek Word Κυβερνήτης, meaning the art of steering a ship, used by Plato in the sense of guiding or governing men. Nowadays, it refers to the study of the control and communication of complex systems, whether they are living organisms, machines or organisations, paying special attention to the →*feedback* as the main way of regulation. It is usually considered that cybernetics has been properly formulated in Norbert Wiener's work of 1948 ("Cybernetics, or control and communication in the animal and machine"). According to Wiener, cybernetics is a science devoted to the study of control systems, especially, self-control systems, whether in living organisms or machines, in which this "control is the sending of messages

that truly change the behaviour of the receiving system". Both in its genesis in the 1940s (with contributions coming from evolutionary biology -von Uexküll-, psychology -Anokhin-, systems control -Wiener-, neurophysiology - McCulloh and Rosenblueth-, psychiatry - Ashby...—as in its last development, cybernetics has constitute an eminently interdisciplinary discipline.

For the epistemologist, anthropologist, and cybernetician Gregory Bateson, "cybernetics is a branch of mathematics dealing with problems of control, recursiveness and information". He also considered it "the biggest bite out of the fruit of the Tree of Knowledge that mankind has taken in the last 2000 years" (Bateson 1972). For Stafford Beer, considered father of management cybernetics, it is "the science of effective organisation".

First order or **classical** ~ and **second order** ~ (S. *de primer y segundo orden*, F. *de premier et deuxième ordre*, G. *erster und zweiter Ordnung*). In 1958, Heinz von Foerster conducted a critical review of Wiener's cybernetic theory, observing that though this theory was introducing significant changes with respect to previous conceptions of regulation and control, it did not involve an epistemological break with the traditional conception of science, because the model, in which the observer watch the object or the system from outside without causing an influence on the observee and attaining an objective study of it, continued to be applied. In the wors of Watzlawick, Beavin and Jackson (1981:33): "Feedback systems are not only different in a quantitatively higher dregree of complexity, but also qualitatively different from everything included within the field of classic mechanics. Their study demands new conceptual frameworks: their logics and epistemology are discontinuous with regard to certain traditional principles in scientific analysis, such as 'isolating single variables' or Laplace's criteria of given a complete knowledge of all facts in a specific moment all future states can be predicted. Feedback systems require their own philosophy, in which the concepts like

configuration and information become so important as matter and energy were at the beginning of this century".

Von Foerster believed that cybernetics should overcome this epistemological anachronism, so that the observer would be part of the system, asserting his own goals and his own role within the system. Since then, there is a clear distinction between traditional cybernetics (or cybernetics of the first order) and cybernetics of the second order, also named complexity theory. Whereas cybernetics of the fist order can be formulated through the question: "What and how are the mechanisms of feedback of the studied system?", cybernetics of the second order entails the question: "How are we able to control, maintain and generate this system through feedback?"

Hence, second order cybernetics is posed as an implicit theory of observation with the range of an epistemology. The step from first order to second order cibernetics is in a sense the step from observing systems to observing observing systems (or systems with observers). In the words of Pakman (Cit. in Von Foerster, 1991:3): "From the very moment in which we quit considering the concepts we use are properties of the systems, then we observe and start conceiving them as an emerging product of the interaction between us and the observed systems (...) we move from ontology to epistemology, from observed systems to our knowledge about them".

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(JMA –ed.- ; JMD, JMA)

CYBERSEMIOTICS (S. *cibersemiótica*, F. *cy-ber-sémiotique*, G Kyber-Semiotik) [transdisciplinary, semiotics, cybernetics] theory

Contents.— *1) Observers within their universe, 2) Cybersemiotics: a crossroad among four knowledge traditions, 3) Peirce triadic semiotic process on-tology as a new view of reality, 4) Cybersemiotics as an integrative transdiscipline, 5) Cybersemiotics vs information the-orists and info-computationalism.*

Cybersemiotics is the attempt to provide a transdisciplinary framework for the scholarly work on information, cognition and communication coming from the natural, technical and social sciences as well as the humanities. It builds on two already generated interdisciplinary approaches: On the one hand cybernetics and systems theory including information theory and science, and on the other Peircean semiotics including phenomenology and pragmatic aspects of linguistics. Cybersemiotics attempts to make the two interdisciplinary paradigms – both going beyond mechanistic and pure constructivistic ideas - complement each other in a common framework.

1. Observers within their universe. We need to realize that a paradigm based on the view of the universe that makes irreversible time and evolution fundamental, forces us to view man as a product of evolution and therefore an observer from inside the universe. This changes the way we conceptualize the problem and role of consciousness in nature compared to what Descartes did with his dualistic paradigm. The theory of evolution forces us theoretically to conceive the natural and social sciences as well as the humanities together in one framework of unrestricted or absolute naturalism, where consciousness is part of nature. This has influenced the exact sciences to produce theories of information and self-organization in order to explain the origin of life and sense experiences, encouraged biological thinking to go into psychology and social science in the form of theories of selfish genes, socio-biology and evolutionary psychology.

But these approaches have still not satisfactorily led to an understanding of why and how certain →*systems* have the ability to produce sense experiences, awareness and meaningful communication. The theories of the phenomenological life world and the →*hermeneutics* of →*communication* and understanding seem to defy classical scientific explanations. The humanities therefore send another insight the opposite way down the evolutionary ladder, with questions like: What is the role of consciousness, →*signs* and meaning in evolution? These are matters that the exact sciences are not constructed to answer in their present state. Phenomenology and hermeneutics point out to the sciences that the type of objective knowledge they produce have prerequisite conditions in embodied living conscious beings imbued with meaningful language and a culture. One can see the world view that emerges from the work of the sciences as a reconstruction back into time from our present ecological and evolutionary self-understanding as semiotic intersubjective conscious cultural, historical creatures, but unable to handle the aspects of meaning and conscious awareness. How can we integrate these two directions of explanatory efforts?

2. Cybersemiotics: a crossroad among four knowledge traditions. What makes Cybersemiotics different from other approaches attempting to produce a transdisciplinary theory of information, cognition and communication is its absolute naturalism, which forces us to view life, consciousness as well as cultural meaning as a part of nature and evolution. It thus wants to combine a number of different platforms from which attempts to make universal theories of perception, cognition, consciousness and communication have been made, by relativizing each of them as only a partial view: 1. The physico-chemical scientific paradigm based on third person objective empirical knowledge and mathematical theory, but with no conceptions of experiental life, meaning and first person embodied consciousness and therefore meaningful linguistic intersubjectivity; 2. The biological and natural

historical science approach understood as the combination of genetic evolutionary theory with an ecological and thermodynamic view based on the evolution of experiental living systems as the ground fact and engaged in a search for empirical truth, yet doing so without a theory of meaning and first person embodied consciousness and thereby linguistic meaningful intersubjectivity; 3. The linguistic-cultural-social structuralist constructivism that sees all knowledge as constructions of meaning produced by the intersubjective web of language, cultural mentality and power, but with no concept of empirical truth, life, evolution, ecology and a very weak concept of subjective embodied first person consciousness even while taking conscious intersubjective communication and →*knowledge* processes as the basic fact to study (the linguistic turn); 4. Any approach which takes the qualitative distinction between subject and object as the ground fact on which all meaningful knowledge is based and considering all results of the sciences, including linguistics and embodiment of consciousness, as secondary knowledge, as opposed to a phenomenological (Husserl) or actually phaneroscopic (Peirce) first person point of view considering conscious meaningful experiences in advance of the subject/object distinction.
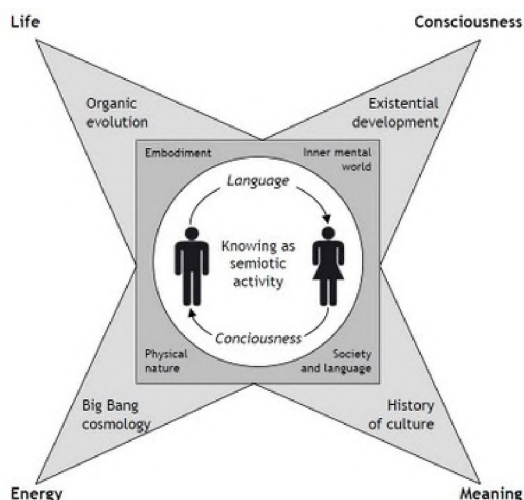

Figure 1. The Semiotic Star: A model of how the communicative social system of the embodied →*mind* produces four main areas of knowledge. Physical nature is

usually explained as originating in energy and matter, living systems as emerging from the development of life processes (for instance, the first cell). Social culture is explained as founded on the development of meaning in language and practical habits, and finally our inner mental world is explained as deriving from the development of our individual life world and consciousness. But all these types of knowledge have their origin in our primary semiotic life-world and the common sense we develop here through our cultural history (horizon). In the course of this development the results of the natural and social sciences as well as humanities feed into our common sense horizon and expands it.

3. Peirce triadic semiotic process ontology as a new view of reality. Peirce's evolutionary metaphysics has a phenomenological point of departure, but he frames the task differently from Husserl as well as from Hegel. Thus, it is most relevant to hold on to the name Peirce invented for his own stance: phaneroscopy. To me, there is a basic problem in modern European phenomenology from Husserl and onward, viz. that when we talk about phenomenology, we cannot get to the world of the others and to the world of objects as they hardly have any existence outside our own consciousness. This is because it deals with a certain view of the pre-linguistic consciousness before any distinction between object and subject. Peirce, however, tries to solve this problem by introducing his three basic categories of Firstness, Secondness and Thirdness and connecting them to the sign process, thus making a common foundation for cognition and communication that makes his theory intersubjective at the basis. First person experience then does not come from a transcendental subject, but from 'pure feeling', or Firstness. Thus, Firstness must be the unanalyzable, inexplicable, unintellectual basis which runs in a continuous stream through our lives and therefore is the sum total of consciousness. Thus, possibility is a good word for Firstness. Existence is an abstract possibility (Firstness) which is no-thing. Peirce equates being with Firstness, as is clear from these two trichotomies: (1) being, (2) actuality, (3) reality; and (1) possibility, (2) actuality, (3) necessity. Here it is important to understand that the cat-

egories are inclusive: you cannot have Secondness without Firstness or Thirdness without Secondness.

Peirce is referring to Hegel's dynamical dialectical thinking as a contrast to Aristotle. Where Aristotle's logic is concerned with separate, discrete phenomena in a deductive pattern, Hegel in his phenomenology dissolves this classical static view into a dynamic movement. This is caused by oppositions between the structural elements that - through their fight with each other - develop towards a new whole, which is usually the whole we have now. It is viewed as preserving the former elements (→*contradiction*) but now united into a new higher synthesis. This dialectics is a much more organic way of thinking than the more mechanical classical logic. Hegel's term for this overcoming of contradiction at a new level, which at the same time preserves the contradiction on a lower one, is Aufhebung. The concept is sometimes translated as "sublation".

There is a lot of Thirdness in Hegel's phenomenology as well as an intuitive apprehension of the total picture, or Firstness. What is missing - from a Peircean point of view - is then that healthy sense of reality that Secondness provides. It is the brute facts on which everyday consciousness and self-conscious experience confronts in that it does not flawlessly conform to our expectations. The resting of reality in Peirce's analysis. We have to reflect on what the brute facts say about Thirdness and this is the road to science. Thus Hegel does not – in Peirce's view – see that the difference between Firstness, Secondness and Thirdness is foundational and that there is no way in which one of them can be turned into one of the others, nor does he realize that they cannot melt together into one whole.

4. Cybersemiotics as an integrative transdiscipline. The phaneroscopic semiotics includes an intersubjective base as Peirce considers all knowledge to be intersubjectively produced through signs and view emotions

and qualia as Firstness. The integrative transdisciplinary synthesis of Cybersemiotics starts by accepting two major, but not fully explanatory, and very different transdisciplinary paradigms: 1. the second order →*cybernetics* and autopoietic approach united in Luhmann's triple autopoietic system theory of social communication; 2. the Peircean phaneroscopic, triadic, pragmaticistic, evolutionary, semiotic approach to meaning which has led to modern *biosemiotics*, based in a phenomenological intersubjective world of partly self-organizing triadic sign processes in an experiential meaningful world. The two are integrated by inserting the modern development of information theory and self-organizing, emergent chemico-biological phenomena as an aspect of a general semiotic evolution in the Peircean framework. This creates the Cybersemiotic framework where evolutionary experiential and intersubjective sign processes become the ground reality on which our conceptions of ourselves, action, meaning and the word are built. None of the results from exact science, biology, humanities or social sciences are considered more fundamental than the others. They contribute on an equal footing to our intersubjective, semiotic process of knowing ourselves and the world.

Thus, all four approaches: physics, biology, phenomenology (awareness and intentionality), and sociology/linguistics are all equally important and therefore have to be united into a transdisciplinary theory of information, semiotics, first person consciousness and intersubjective socio-cultural communication. The Cybersemiotic Star model illustrates this, while at the same time pointing to the fact that the discussion about transdisciplinary knowledge is conducted in a linguistic discourse with other embodied and linguistically-informed consciousnesses in both a natural and cultural Umwelt.

Looking at The Cybersemiotic Star we see that there are four forms of historical explanations going on: 1. the cosmological, 2. the biological,

3. the historical, and 4. the personal life history. The natural sciences work towards making one grand historical explanation; but so far, we have not cracked the problem of the emergence of life and consciousness in evolution, I have argued here. Thus we might have to accept that an all-encompassing explanation of the conscious meaningful human communication process cannot be provided from any of the corners of the model alone. We cannot so far reduce our scientific explanations to one grand story, but, instead, have to juggle with all four at the same time, as long as they have the present paradigmatic foundations.

Each of the four corners of the star represents different kinds of epistemologies. In science we have – as prerequisite outside the theory – several living, embodied conscious subjects linked by knowledge sharing in language confronting one or more objects. The first person living consciousnesses of the subject(s) as observers are considered to be outside the world they observe. In the biological sciences the observers share the life experience with their objects that are also living and therefore experiencing. It is sadly often forgotten in molecular definitions of life that it is a basic and common trait of all life that it senses and experiences, a fact not easily explainable from a molecular level. We can kill the life we investigate to find out the molecular structure, but then we are returned to physico-chemical approaches as the life and the agency of the living is gone. But when studying living beings in the state of being alive, sensing their surroundings and creating their own Umwelt, we are in a qualitatively new situation, as we have to accept that the living systems experience the environment in a specific manner, which will most often be partly different from ours. Thus we are in a second order situation of observing.

5. Cybersemiotics vs information theorists and info-computationalism. A common view among information theorists is that information integrated with entropy in some way is a basic structure of the World. Computation is the process of the dynamic change of

information. In order for anything to exist for an individual, she must get information on it by means of perception or by re-organization of the existing information into new patterns. This cybernetic-computational-informational view is based on a universal and un-embodied conception of information and computation, which is the deep foundation of "the information processing paradigm" (s. →*General Theory of Information*, →*Info-computationalism*). This paradigm is vital for most versions of cognitive science and its latest developments into brain function and linguistic research. Taken to its full metaphysical scope this paradigm views the universe as a computer, humans as dynamic systems producing and being guided by computational functioning. Language is seen as a sort of culturally developed algorithmic program for social information processing.

What seems to be lacking is knowledge of the nature and role of embodied first person experience, qualia, meaning and signification in the evolution and development of cognition and language communication among self-conscious social beings and formed by the grammatical structure and dynamics of language and mentality. From a general epistemological as well as philosophy of science foundation, it is argued that a transdisciplinary paradigm of information, cognition and communication science needs, within its theory, to engage the role of first person conscious, embodied social awareness in producing signification from percepts and meaning from communication in any attempt to build a transdisciplinary theoretical framework for information, cognition, signification and meaningful communication. It has to embrace what Peirce calls cenoscopic science or, to use a modern phrase, intentional sciences. If it does not do so, but bases itself on physicalism, including physicalistic forms of informationalism such as →*info-computationalist* naturalism, it is going to be difficult to make any real progress in the understanding of the relation between humans, nature, compu-

tation and cultural meaning through an integrated information, cognition and communication science.

6. Cybersemiotics groundings

A theory of signification and how meaning is produced through signs is needed to connect human consciousness with a theory of nature and information. For this we need to enlarge the picture by superimposing and integrating an even broader foundation such as Charles Sanders Peirce's pragmaticistic semiotics in its modern development as biosemiotics. The first ground work to explain why and how such a combinatory framework of semiotics and cybernetics makes it possible to make an evolutionary based transdisciplinary theory of information, cognition, consciousness, meaning and communication can be found in Brier (2008a) and in the subsequent papers written after the book manuscript was finished (Brier 2007, 2008b, ff).

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(SB)

D

DATA (S. *dato*, F. *donnée*, G. *Daten*[PL], *Angabe*) [transdisciplinary, information science, computation science, communication theory, epistemology] concept

Contents.— *1) Data at organizational context, 2) Floridi's Model (a. Diaphoric definition of data, b. Types of data)*

Intuitively, we can identify the data as physical events (small parts (or pieces) of reality) able to carry certain associated information. They have a material nature and can be considered as the physical support to information. In other words, they are physical facts that do no have any inherent meaning, do not necessarily present any interpretations or opinions, and do not carry indicative characteristics that may reveal their importance or relevance. In this sense, each of the statements printed in this article can be considered as data. The customer's name, the amount of the purchase or bank transaction number that appears on an invoice can be considered as the typical examples of data within the context of the companies.

In an effort to systematize, we can offer the proposal from the following definition:

Data = physical support of information.

1. Data at organizacional context. It is important to show some characteristics of the data from these viewpoints. Firstly, the question of being some physical events, the data are easy to capture, structure, quantify or transfer. Secondly, a datum, depending on the encryption key in which it is involved (as discussed below), it can be conventional or natural (not conventional).The account number on the back of a credit card is an example of a conventional type of data. Looking at clouds that appear in the sky just before the storm is an example of natural or non-conventional data. Thirdly, the same data can inform an agent or not, as we see below, depending on the stock prior to the staff. Fifthly, within an organization, data are usually of conventional type and they often appear as a collection of materialized alphanumeric characters on a document (either physical or electronic). And finally, in the same context, in the organizations, the indiscriminate accumulation of data does not always necessarily improve decision making.

We can justify this way of defining the concept of data by reviewing how the same concept is understood in other contexts. For example, our characterization reflects the sense that no tension is given to the concept of data in the disciplines of information technology and telecommunications: a set of associated characters of a concept. The character set "35,879,987" about the concept number of national identification (ID) could be an example.

In the same vein, our proposal fits well with the use of the word "data" when defining certain informatic applications. A database management system (SGBDD), without going any further, usually is defined as a resource that enables the management of records from the data or sets of characters appearing in the records (numbers, words, numbers, etc..) That is to say, one can defend the idea that management of the records of these tools is a management of syntactical type (apart from character sets that appear in the records) but not a semantic one (apart from the information content associated with these sets of charac-

ters). A SGBDD, facing a search equation, retrieves the records where the data appear to make the equation. In the same way, a Data Mining or Text Mining system, among other things, permits to detect correlations or patterns among data (or sets of characters) that appear in the records which shap the system so that later in an intellectual manner someone can decide whether this pattern is consistent or not with a genuine correlation semantics.

2. Floridi's Model.

a) Diaphoric definition of data (DDD). According to the diafora definition of Floridi (from the Greek διαφορά, →*difference*, discrepancy) "a datum is a putative fact regarding some difference or lack of uniformity within some context."

According to the author, this definition can be applied at three levels: 1) *Diaphora de re*: as a lack of uniformity in the outside world, i.e. pure data, before any epistemological interpretation (similar to Euclid's "dedomena"). 2) *Diaphora de signo*: between at least two physical states. 3) *Diaphora de dicto*: between two symbols.

Due to the stance concerning the ontological neutrality and the nature of environmental information, (1) can be identical to (2), or make possible the signs in (2), while those signs are necessary conditions for encoding the symbols in (3).

This definition has the advantage of leaving the data free from its support and considers four types of independence or neutrality: taxonomy (with regard to the classification of the relata), typological (with regard to the logical type); ontological (with regard to the nature of the inequality support), genetic (regarding to the semantics of the informee).

In turn, these four types of neutrality have important implications regarding the nature of information and data:

According to the *taxonomic neutrality*, there is nothing that can characterize a datum per se.

Consequently, they are purely relational entities.

According to the *typological neutrality*, the information may consist of different data types as related: →primary, secondary, metadata, operational or derivative (see below, §2.b).

According to the *ontological neutrality*, in combination with the rejection of information without data -as stated by General Definition of Information the author proposes-, there can neither be "without data representation". Therefore, at the same time, this may imply different levels of ontological neutrality: 1) there can be no information without physical implementation (regardless of its nature), 2) every elements in the physical world "derives its function, its meaning, its very existence from the appartus-elicited answer to yes-or-no questions, binary choices, bits" (i.e., what we call reality derives from a theoretical-interrogative analysis), 3) information is nothing but an "exchange with the outer world as we adjust to it, and make our adjustment felt upon it" (Wiener, 1954). 4) "information is a difference that makes a difference". So the meaning becomes a potential basis accoding to its self-generating ability.

According to the genetic neutrality, semantics can be independent of the informee, thus meaning does not have to be in the mind of the user; which is not the same as the realist thesis, stating that the meaning would even be independent of the producer or informer. This latter assumption is made when "environmental information" is considered.

b) Types of data. Data can be of different types supported by the diaphoric definition:

Primary ~: those that are explicitly related to what is in question (eg. the response of an information system to the query of a user).

Secondary ~: equivalent to the absence of certain primary data (eg. administrative silence in front of a determined petition o request).

Operational ~: those data relating to the operations and the overall system information

performance (eg. an indication that the system is not working properly or it is busy).

Derivative ~: those data that can be used as indirect sources in inquiries different to those directly or primarily addressed by the data themselves (eg. "The fact that someone has mentioned the sun twice is a sign that he is in a good mood").

Meta~: information about the nature and characteristics of other data, usually primary data (eg. "What he/she is saying is a lie", "this text is stored in an extended ASCI code," "in the data received there are not any detected errors "...).

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(MPM –ed-; MPM, JMD, MG)

DIALOGIC VS. DISCURSIVE (S. *dialógico vs discursivo*, F. *dialogique vs discursive*, G. *dialogik vs. diskursive*) [transdisciplinary, communication and media theory, information society] concept, problem

Flusser, in his theory of communication, "Kommunikologie" (1996), warns of the danger that chiefly discursive media, in which communication is disseminated or distributed (as television, radio, etc.), could end up smothering the dialogical media. While, in the latter, information is created (e.g. in scientific discussions, interviews, meetings, etc.) the former only disseminates it. Thus, Flusser's warning concerns creativity. This assessment is double faced: on the one hand, it is epistemological in the line started by Socrates, opposing a dogmatic and limited thinking to a dialectical and open one; on the other hand, it is socio-technological, according to which, particularly Internet might not be the genuine democratic communication, as it pretends to be; on the contrary, its democratic character might be dominated by hierarchical structures conditioning that information is to be chiefly broadcasted –sometimes in a subtle manner- from centres of information and power domination (→*Critical Theory of Information*).

A theory of information based on a communication model as the one used in the Mathematical Theory of Communication (MTC) – rooted in semiotic theories of significant influence in the history of ideas, such as Locke´s theory– might better account for discursive communication than dialogical one (Díaz & Al Hadithi 2009, →*communication*). Regarding to this –so to speak- "simple model", information might be considered as transported properly codified and next received by means of a pertinent decoding operation (→*code*): according to Locke, "the idea they make it a sign of is precisely the same" [for both the emitter and de receiver] (Locke 2004, III-ii-4); in the MTC, the receiver "performs the inverse operation of that done by the transmitter", and such invertivility presupposes an isomorphic relation between the emitter and the receptor symbolic domains (Shannon 1948: 380). However, the idea that this "simple model" may be the case of discursive communications is just an ingenious point of view, in the sense that an automatic tuning between the emitter coding and receiver decoding is presupposed,

which is all the more difficult to admit, if the heteronomy between emitter and receiver is higher. In short, even though the relative autonomy of both coding and decoding operations in discursive communications seems to approach the simple model, the heteronomy of these operations –at the same time conditioned by the domination structures, referred by Flusser- leads to a practical significant distance between them (→*message*).

Concerning dialogical communications, a model able to reflect this type better has to emphasize the procedural and cooperative character of information as well as the pragmatic situation where it takes place and in which the sense of the utterances is articulated. Whereas in discursive communication the →*context* (in broad sense) plays a secondary role and it is often ignored, in the case of dialogical communication the context plays a crucial role. On the other hand, the referred heteronomy or emitter/receiver asymmetry of discursive communications, where the role of the receiver is minimised or reduced to a passive subject, becomes a balance between partakers in the dialogical ones. Here, the reception process is enhanced and the homonymy plays a transcendental role. Finally, while discursive communications can be related to a vertical structure (from a privileged position to a subordinated one), a more horizontal structure corresponds to dialogical communications (→*message*).

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(JMD)

DIFFERENCE (S. *diferencia,* F. *différence,* G. *Unterschied*) [transdisciplinary] concept

Difference denotes a relationship between two entities, or objects, or between an entity and itself in different circumstances. A and B are said to be different if the same property or attribute, applied to both, yields non equal values.

The definition of information presented by Gregory Bateson, "a difference that makes a difference" is famous in the bibliography of information.

Floridi also uses the term difference, relating it to the most basic informational situation, the definition of "datum".

However, to use the concept of difference as the deepest substrate of the concept of information is dangerous, since it ignores a fact which is even more elementary or fundamental. For a difference between two things to exist, it necessarily must relate to qualities or attributes of both. For example, if an observer reported that John is higher than William, he or she is recognizing at least three previous facts:

— John and William are objects.
— It makes sense to apply the "height" attribute to both John and William.
— The "height" attribute comes from a consensus reached by a community of agents, which defines the word itself, defines the attribute as a function that assigns a real number to material objects and defines acceptable forms of calculating the function. This is all part of the common sense or ontological background of that community.

Only if these three facts or previous items exist the observer can state that the height of one differs from the height of the other. This can also be seen when someone says that there is a difference between the objects A and B. It is very likely that anyone who is listening would ask: "In what (quality) is it that they differ?". Whenever A and B are different, it is because of a quality or property they both have.

Now, when Bateson uses the phrase above to define information, probably refers to the perception of a difference perceived by an observer, whose state, as a result of the perception, is altered, i.e. differentiated from the state existing prior to it.

When Floridi mentions "difference" he refers to the difference produced in, for example a sheet of paper, when somebody writes on it. In other words, he points to the change of state of a record, between two different time points. This operation is usually used to record information, by means of consensus symbols, and that is the relationship between difference and information that Floridi puts forward.

We see that both uses of the word "difference" are not equal; although one could build a relationship between them. For example, a word written on paper might be perceived by an observer and it could trigger therein a state change. However, clearly, Bateson refers to the domain of perception and knowledge, while Floridi refers to the domain of objects and records.

In conclusion, supporting a definition of the concept of information only on the concept of "difference" we incur the risk of forgetting that first we need categories and qualities collectively agreed, and the risk of confusing information with records and representations of it.

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(RG)

DIGITAL DIVIDE (S. *brecha digital*, F. *fracture numérique*, G. *digitalen Kluft*) [Information society, globalisation, economy] concept

The development of Information and Communication Technology (ICT) and the exponential growth of information, two features of the knowledge-based society, are the pillars where the digital divide is based upon. ICT requires infrastructure and economic means to sustain itself as well as knowing how it works, the possibilities it offers and its appropriate use. This may bring about a two-sided digital divide: on the one hand, those who have the technological means and infrastructure and those who do not. On the other hand, we find those who know how to use them and those who do not. This gap is an aspect that emphasizes the social and economic contrast that encompasses countries, communities, social groups and individuals. One way to deal with this gap is through teaching and training people by means of lifelong learning. In this regard, the new literacies are: digital literacy, technology literacy, multi-literacies, and information literacy (INFOLIT). INFOLIT aims at training autonomous learners who will become capable of analyzing, selecting, assessing and using information to create new content or develop their work or leisure time.

The Organization for Economic Co-operation and Development (OECD) defines the concept of digital divide as having access to computers (ICT) and Internet and knowing how to use these technologies. However, OECD understands technology as a social process which calls for exploring a wider meaning of this concept. Within this framework, libraries are supposed to assume the responsibility of reducing the digital divide through ALFIN proposals. This is understood as considering technology means, information and information management experts. Nonetheless, development politics has given priority to digital or technology literacy without people having the required information literacy. Information literacy is a must since understanding and assessing information is a requirement to use technology tools appropriately and widespread to mediate information access and use. Knowledge is a powerful tool to fight against poverty. However, not all societies are ready to assume these changes and commitments. So it is necessary to make sure that knowledge economy does not aggravate

inequalities between a productive sector and goods and services, where growth is based upon, and a periphery unable to produce them.

It is possible to wonder whether the increase of information technologies generates new gaps locally or internationally, or whether they can improve the wellbeing of our societies. In this regard, UNESCO (2005) points out that the existence of the digital divide is undeniable. However, it says that there is a more troublesome problem: the digital divide separates developed countries from developing ones, especially those less privileged. This digital divide runs the risk of deepening while other gaps emerge or widen in different societies. It accumulates the effects of different gaps found in the main fields of knowledge, information access, education, scientific research and cultural and linguistic diversity. This represents the real challenge raised to build a knowledge society. This gap is based on the own inequality dynamics related to knowledge. These are worldwide inequalities which stem from the distribution of the potential cognition (among other knowledges), or the unequal appraisal of certain types of knowledges with regards to knowledge economy. This gap is apparent among countries form the North and South, but it is also evident within each society. Having access to pertinent and useful knowledge does not depend on infrastructure, but training people in developing cognitive competencies and proper regulations on access to content. Keeping people in touch by means of wire and optic fiber is not enough, unless this connection goes along with the creation of competencies and work addressed to produce

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(EM)

DISINFORMATION (S. *desinformación*, F. *désinformation*, G. *Desinformation*) [transdiciplinary, communication, medias, semantics]concept, problem

Factual information that intentionally does not comply with the facts. It refers to a false semantic content that, distinguishing from *misinformation*, comes from a well informed source. It is also used in the sense of silencing or hiding the truth of the (relevant) facts, especially in the context of mass media (situation in which recipients do not have the possibility to answer the →*message* sent by the emitter, being also unable to control its veracity).

For most of the approaches to semantic information, and even for the common notion of information concerning facts, disinformation cannot be counted as legitimate information. There are, however, some semantic interpretations allegedly neutral with respect to the value of truth of its contents. Nevertheless, as Floridi states, if such neutrality position concerning truth is held the following problems arise: 1) semantic value of false information; 2) informative value of necessary truths -including tautologies-; 3) non redundancy of "it is true that p", being p genuine semantic information.

In any case, as said before, disinformation is not usually considered as semantic information. Thereby in Dreske's work or in →*situation theories*, disinformation is excluded as a subset of false information, whereas genuine information is characterized by a requirement of truth. But more specifically, Floridi's *strongly semantic approach* excludes disinformation under its veracity requirement. Although this might involve a certain inadequacy to the facts, it demands a strong adequacy to the reflection of these facts in the emitter (Floridi 2005). This truthfulness commitment has a family resemblance with the pragmatic and intentional approach of Grice, according to which an effective communication must be regulated –among others- by a maxim of quality (truthfulness) (Grice 1989).

A whole critical trend on information media, especially mass media, followed by a number of different schools, intends to unmask those disinformation situations, especially concerning institutionalized practices. One of the arenas in which this concern has played a central attention is the Frankfurt School (Horkheimer, Marcuse, Adorno and afterwards Habermas (2001), →*Critical theory of information*). Also, the studies of W. Benjamin (2008), Mirin, Baudrillard, Bordieu (1999), Ramonet (2002), Mattelart (1986), Dan Shiller (2002), etc. have deepened in different ways the characterization of dis-information in mass media, as well as its psychological, societal, political and cultural consequences.

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(JMD)

DOCUMENT (S. *documento*, F. *document*, G. *dokument*) [transdisciplinaryy, documentation, LIS, information management] concept

A document is a message delivered with a communicative intention, potentially informative and reusable for the receiver. It is an informative item.

Generally speaking, one can assert that documents have always been involved in humans' intellectual activities. From the beginning of the history of thought, man has used a number of objects or materials where he can capture and store his thought or feelings. There are clear examples of such objects or materials: the cave paintings, Mesopotamian clay tablets, the walls of sacred buildings Egyptian papyrus, the parchments and later the paper. Nowadays, the development of communication and information technologies increasingly contributes to electronic formats in collecting our intellectual production.

We usually use the term "document" to refer to all such objects or materials. In other words, we can identify any type medium that holds some types of information as a document. In this sense, we can consider under the concept of a document a written paper, a book, a photograph, a videotape, a DVD, a file created with a word processor, a database or even a web page. To give a definition: Document = any medium where information is represented.

It is clear from the definition that document has two dimensions: on one side, it is something physical/material and on the other, it holds/contains an associated information or

informative content. Here we see the relationship between these two dimensions with the concepts of data, information and knowledge.

The relationship between the two concepts of document and data seems quite simple. If we consider data is as the physical medium information, document should be understood as (a special type of) combination of data.

Now, let us see what happens to its relation with the concept of information. If information is understood as the semantic content of data derived from an encryption key, document would appear to be as the material object that can represent and implement information.

This representation and materialization helps to explain several things. On the one hand, it explains how you can transmit information: the information is represented (associated with) in (to) a document by a code and its transmission is realized by the material transmission of the document itself. On the other hand, it also makes it clear that why the preservation and storage of document means the preservation and storage of the information it contains therein. One can only analyze this document under the same codification key (or code) used to associate it with that particular semantic content for retrieving the information after storage of the document.

Finally, we tackle the articulation of the concept of document against the knowledge. Knowledge should be understood as those of mental states of an individual that is constructed from the assimilation of information and that controls the actions of the subject. Document, facing these mental states and from its physical dimension and ability to carry information, plays an important role: it appears as the material object, which can represent and implement those mental states residing exclusively in the head of people. This representation and realization, as happened in the case of information, helps to explain the transmission and storage of (explicit) knowledge from the transmission and storage of documents.

In this regard, on one hand, the knowledge in an individual represents (is reflected) in a document by a code and its transmission is realized by the material transmission of the document itself. When a second individual is able to obtain the information associated with the transmitted document to form a new state of mind by it, we can affirm that there has been a transmission of that knowledge. On the other hand, by the same mechanism, the preservation and storage of the document obtained as a fruit of representation of a concrete knowledge also allows the preservation and storage of that knowledge. One can only analyze this document under the same codification key (or code) which used in the representation of those mental states to be able to retrieve the associated information and create new mental states in other individuals after storage of the document. In this way, this knowledge can be retrieved by anyone who needs it at the right time.

In the same vein, to give a brief outline, it is also important to mention one more thing that can make clear this entire conceptual scenario. We should not forget that, at certain occasions and in colloquial terms, we often classify a concrete data as information or knowledge. We also, usually in an organizational context, use the terms "knowledge" and "information" to refer to physical representations of the mental states, or the informative contents, to refer to documents (in any medium (paper, electronic , optical, magnetic, etc..)) we use to represent and disseminate that knowledge or information. For example, if a document (a fact, a physical occurrence) carries some information or is obtained as a representation of a knowledge that a subject has, in a larger sense, we say also that this document is respectively information or knowledge.

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(BR –ed.-; MPM, BR)

DOCUMENT CONTENT ANALYSIS

(S. *análisis del contenido documental*, F. *analyse de contenu documentaire*, G. *urkundliche Inhaltsanalyse*) [Research] concept

Discipline devoted to the identification of the main concepts or realities in a *document* and the representation of them in order to enable an ulterior retrieval by the users.

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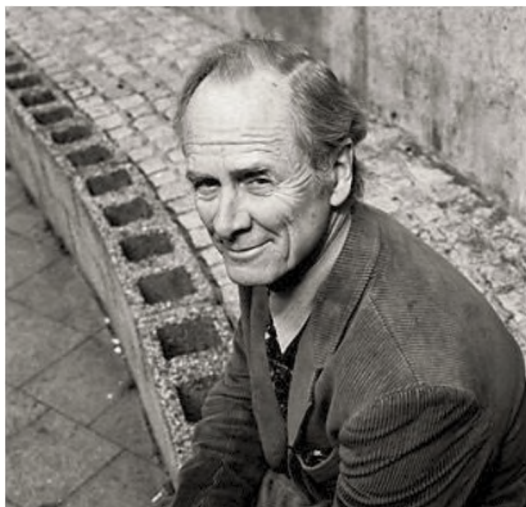
(BR)

DRETSKE, FRED [Philosophy, epistemology, philosophy of mind] author

American philosopher (born 1932) that, from externalism, has made significant contributions in the field of information theory, epistemology and philosophy of mind. Throughout his entire academic career, he has taught at the universities of Wisconsin, Stanford and Duke. Within his scientific works are: Seeing and Knowing (1969), Explaining behavior: Reasons in a world of causes (1988), Naturalizing the Mind (1995), Perception, Knowledge and Belief (2000).

But among all of his works there is one that stands out, published in 1981 under the title Knowledge and the Flow of Information. At that time he was still a professor at the University of Wisconsin-Madison and it was before his collaboration at the prestigious CSLI (Center for the Study of Language and Information) of Stanford University as a lecturer and researcher. At that time, this work attracted the attention of the specialized literature and later was the backbone of a significant amount of the subsequent philosophical production. The main objective of Dretske is this book was to carry out a conceptual journey through the mental territory, trying to develop a semantic theory of information that was useful for later analysis of principal processes, such as knowledge or belief involved in our cognitive behavior.

And to achieve this objective, it seems that the work is divided into three distinct parts. The first part begins with the attempt to present a semantic theory of information, or a theory of propositional content of a sign. Then he recovers the notion of average amount of information contained in the Mathematical Theory of Communication (Shannon and Weaver, 1949), and from there he offers a definition for informative content. In particular, a sign informs about an occurrence in the world when there is a law or regularity between them that prevents a sign from occurring without the occurrence taking place (or expressed in probabilistic terms: when the probability of causing the occurrence, once the signal has occurred, is equal to 1). Within this conceptual proposal there is no place for false information. False information can not be regarded as authentic information.

(Duke University / Faculty database Philosophy Arts & Sciences)

In the second part he presents his alternative definition of knowledge: belief caused by information. Here Dretske replaces the need for the justification of belief in the causality of information. By this change he tries to overcome the problems (the counter examples of Gettier and the paradox of the lottery) that the classical epistemological theories usually presented and also enfores a suitable argument against the thesis of radical skepticism. In the third and final part of the work, the author's purpose is to offer a definition of the content of belief, explanatorily compatible with its characterists: its intentional character, the possibility of possessing a false content and its determined role in the conduct. The objective is fulfilled when it identifies the content of the belief with fully digitized information. In the same way, the concepts are considered as internal structures that are distinguished by their semantic content, and when they are exemplified, they apply a control over the outputs (conducts) of the cognitive system.

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(MPM. –ed.-; MPM., MG)

E

EMOTION (E. *emoción*, F. *emotion*, G. *Emotion*) [psicología, evolución] <small>concepto</small>

"Do we cry because we are sad, or rather are we sad because we cry?" (W. James)

Before answering please consider the following simple experiment. In any moment you do feel sad, take a pencil and bite it for a couple of minutes. You eventually find yourself then smiling and finishing your sad state. Now answer the previous question.

Emotion is the affective tone with wich organisms respond to their circumstances. Three research lines are to be highlighted in the study of emotion, with respective antecedents in Charles Darwin, William James and Sigmund Freud.

Emotions arise from filogenetically selected behaviours. It may happen that obsolete conducts remain, even if they are no longer fit to present demands. For example, many persons are still afraid of snakes, while it is so unprobable to find any wild snake in daily life. It would be more fitted for us to be afraid of plugs, hobs or lifts, since they really endanger our lives.

Even if it is common to undistinctively talk about emotion and feeling, there are differences between them, particularly as to their duration. Emotion takes about miliseconds, while feelings are more durable and also later result of filogeny in our brain. Emotions are located in the limbical system while feelings in the orbito ventral area.

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(CR)

ENCODER AND DECODER (S. *en*, F. *codificateur / decodificateur*, G. *Kodierer / Dekodierer*) [transdisciplinary, communication theory, telecommunication] <small>concept</small>

Encoder is a device for converting data or signals by using a specific code. It is normally used with four clearly differentiated purposes: 1) To remove redundancy or anything that is not going to be perceived by the information receiver or remain beyond the quality goals of the received signal, typically named *source encoder*; 2) To increase redundancy, so that the decoder can eventually detect and correct the errors occurred within the reception of signals or symbols, named *channel encoder*; 3) To make

the coded data unreadable, except if the recipient knows the code, by using *encryptors* or *ciphers*; 4) To allow the transmission of data through a channel with certain resources and limitations, corresponding in the MTC communication model to the *transmitter-encoder*, also named *modulator* -especially in telecommunications-.

The **decoder** (E. decodificador, F. decodificateur, G. Dekodierer) is the device performing the inverse operation of the encoder, whatever the purpose of the code: 1) the source decoder tries to restore the eliminated redundancy; 2) the channel decoder removes the redundancy that has been introduced by the corresponding encoder, and correct those errors being detected; 3) the unencryptor makes the data readable; and 4) the demodulator or receiver-decoder identifies the symbol transmitted through the channel –normally according to a maximum likelihood criterion– and restate the data into its original form, i.e., how it was before the modulator.

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(JMD)

ENDOGENOUS INFORMATION (S. *información endógena*, F. *information endogène*, G. *endogen/körpereigen information*) [cybernetics, epistemology, constructivism, theory of complex systems] concept

Contents.— *1) Difference and distinction, 2) The objectivist position, 3) The constructivist position, 4) The radical constructivist position.*

1. Difference and distinction. The generalization involved in the common use of the reified idea of information must not hide the complexity and richness of the debate it has produced. Debate which significantly emerges

from the contradictions inherent to Shannon's formulation -summarized in the two italicized sentences-:

«The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have meaning; that is they refer to or are correlated according to some system with certain physical or conceptual entities. *These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that they are selected from a set of possible messages»*. (Shannon y Weaver, 1949:31-32)

As Bateson (1985:413) rightly pointed out, «the engineers and mathematicians believe that they can avoid the complexities and difficulties introduced into communication theory by the concept of 'Meaning'» reducing the matter to the syntactical level and building the concept of information from a theory of signals (von Foerster, 1991:60). However the idea of signal is only apparently aseptic, and only apparently syntactical. The signal refers to a difference that is 'out there', but that 'something' which is difference is *distinguished* by someone. The distinction is presupposed by Shannon and Weaver in the form of selection (see Qvortrup, 1993). The fact that information is defined as the probability of selection involves the observer in at least two aspects: first, probability implies expectation and context of use; and second, the selection is only conceivable on the basis of the assumption of *someone* who selects. In both cases there appears implicit semantics as a horizon of meaning (Brier, 1992).

Moreover, the development of the concept of information as a measure of order which constitutes its fundamental link with universal magnitudes (such as mass or energy) presupposes the observational act as well. In Shannon and Weaver's theory, both information and noise depend on variety. If redundance is defined according to the "adjustment" be-

tween variety and the number of elements, information and noise are expressed in direct proportion to variety. In other words, information and noise depend on the number of elements *different* from one another. Neither of them can be defined in larger quantities than those allowed by the amount of variety (Ashby, 1977:238). In fact, as Ashby poses,

«It must be noticed that *noise is in no intrinsic way distinguishable from any other form of variety*. Only when some recipient is given, who will state which of the two is important to him, is a distinction between message and noise possible». (Ibid.:256)

The issue of the *distinction* between information and noise brings us definitely to the problem of observation. It seems implicit in Ashby's words that order is the cognitive contribution of the observer that makes it possible to conceive the difference between information and noise: order, as a Peircean sign, it is so *for someone in a certain circumstance*. The consequent paradox is that information is proposed as a universal measure of order for a system whose activity of selection (to which information depends on) involves a local order, coherent with its structure and operations. From the point of view of communication (understood as 'transmission' of information), there has to be a correspondence between the orders of selection of the observing systems involved and, therefore, there has to be an operational and structural correspondence between them (von Foerster, 1991:75).

The epistemological contradictions of information ultimately refer to its condition as a code of difference. Consequently, it is primarily an observational problem, a problem of the management of differences. In this sense, and partially following Qvortrup's classification (1993), it is possible to outline at least three differentiated positions throughout the contemporary debate on the epistemological status of information:

2. The objectivist position (a), according to what has been posed before, considers infor-

mation as an ontologically self-sufficient magnitude of Nature. In this case, the information is *an external difference* to the observer and independent from him. Without resorting to Stonier's ontological exaltation in which the independent existence of information is remarked as "a basic property of the Universe", Wiener's words suffice to illustrate the common denominator of this approach and its cognitive-communicational derivations:

«Information is a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it. The process of receiving and using information is the process of our living effectively within that environment. To live effectively is to live with the adequate information». (Wiener, 1954:18)

3. The constructivist position (b) introduces in the concept of information the observational instance as a result of the systematic reflection on the contradictions pointed out in the objectivist approach. The development of the second-order cybernetics placed self-reference in a privileged position within the operations of the cognitive system, making impossible the conception of the informational flow in terms of transmission of objects. The constructivist shift established thus two complementary options: either (b.1) reviewing the concept of information, so that it became coherent with an idea of communication understood as a behavioural coupling between two interacting systems, or (b.2) establishing the hypothesis that the environment only exists for the system as a product of its own creation. The one we call 'constructivist position' corresponds to the first option (b.1), while the one we name 'radical constructivism' will emerge from the development of the second hypothesis (b.2).

The first option, derived from the incorporation of the observational reflexivity, compelled thus the consideration that communication did not depend so much on what 'the environment gave the system' but rather on what happened with the system in its interaction

with the environment or with another system (Maturana and Varela, 1996:169). Thus information ceased to be a 'capturable' external difference and came to be conceived as a difference in the environment linked to an operational change (a difference) in the system. The Batesonian definition of information as the *difference that makes a difference* (Bateson, 1985; 1991) summarises the conception of communication as operational coupling and in a way advances the second constructivist hypothesis. In fact, for Bateson the difference is an observational operation that emanates from the encounter between the perceptive structure of the system and the world as it is presented to it. Implicitly the difference is neither in the world nor in the observer, but in the encounter between them. Also implicitly (b.2): the world can only be for the observing system depending on what it is (that is, the environment is part of the observing system inasmuch its operational structure presupposes it). Consequently, the difference is after all defined as a mental issue.

4. The radical constructivist position (c) introduces, thus, a differential note with respect to Bateson's definition. Paraphrasing the famous sentence, information would appear from this perspective rather as *the difference that finds a difference* (Qvortrup, 1993). In fact, this implies an elimination of the conductist substratum that remained in Bateson's formulation, in the sense that it made possible glimpsing a cause-effect coordination between the difference in the environment and the difference in the observing system. The consideration that the environment exists for the system depending on its operational structure obliged to restrict the functional determinism of the cause-effect connection in the system-environment encounter, especially when one was careful enough to highlight that communication was in no circumstance a traffic of differences from the environment to the system and vice versa.

This view of information as an endogenous emergence of the operational coupling implies the conception of selection not in the terms of

a designation or a 'pointing at' with respect to something external, but as a restriction of the system operation itself. In other words, the system does not select differences of the environment; the system *is* in itself a selection of the differences in the environment. As in the previous case, the premise refers to a double hypothesis: on the one hand (c.1), the consideration of the set system-environment as an inseparable whole for the external observer - applicable to self-organising systems, like living systems-; on the other hand, (c.2) the consideration of observing systems as operationally closed systems. The former line of reflection (c.1) is the one developed by von Foerster (especially in von Foerster, 1981), the latter (c.2) constitutes the essence of the autopoietic systems theory developed by Maturana and Varela (1980, 1996 and Varela, 1979, 1996).

In his article *Notes on an Epistemology for Living Things*, published in 1972, Heinz von Foerster (1991:65-78) outlines the following propositional chain: (1) The environment is experienced as if it was the residence of objects, stationary, moving or changing; (2) The logical properties of "invariance" and "change" belong to the representations, not to the objects; (3) Objects and events are not primitive representations. They are representations of relations; in such a way that (4) the environment is the representation of the relations between "objects" and "events" and (5) a living organism is a third order relater (operation of relations between relations of relations) from which the differentiation between system and environment constitutes an emergence from that operation of relations:

«Let be D^* the terminal representation made by an organism W^*, and let it be observed by an organism W; let W's internal representation of this description be D (W, D^*); and, finally, let W's internal representation of his environment be E (W, E). [...] The domain of relationships between D and E which are computable by W represents the "information" gained by W from watching W^*:

$Inf\,(W\,,\,D^*) \equiv$ Domain $Rel\,\mu\;\;(D,\,E)$

$(\mu = 1, 2, 3, \dots\, m)$

The logarithm (of base 2) of the number μ of relationships $Rel\,$m computable by W (or the negative mean value of the logarithmic probabilities of its occurrence $<log_2 p_i = \Sigma\;p_i\,log_2\,p_i$; $i = 1 \rightarrow m$) is the "amount of information, H" of the description D^* with respect to W :

$H\,(D^*,\,W) = log_2\,m$

(or $H\,(D^*,\,W) = -\,\Sigma\;p_i\,log_2\,p_i$) »

In such a way that both the descriptive approach to the concept of information (Inf) and the probabilistic expression of the amount of information (H) prove to be relative concepts (c.1), being thus impossible to affirm that the environment "contains" information, and even less that it is "able" somehow to "transmit it" to the system. The corollary presents somehow solipsist notes that should be made more precise. «The environment *so as we observe it*, is our construction», concludes von Foerster (1981:41). Something similar happens with Varela's affirmation (1979:45): «Information, *sensu stricto*, does not exist». It is important, as Qvortrup (1993) recommends, to underline the qualifications "*in the way we observe it*" and "*in strict sense*" modalizing each of the two previous sentences. Both qualifications refer to the recursive nature of observation. In von Foerster's terms, both precisions remind us that *observations cannot be made without an observer*, or as Varela himself points out:

«The fact is that information does not exist independent of a context of organization that generates a cognitive domain, from which an observer community can describe certain elements as informational and symbolic». (Varela, 1981:45)

From the perspective of autopoietic systems (c.2), the operational closure of the observing system makes that endogenous conception of information a logical requirement

«Autopoietic systems do not have inputs or outputs. They can be perturbated by independent events and undergo internal structural changes which compensate these perturbations». (Matura and Varela, 1980:81)

As a consequence, what is normally perceived as interaction (in the sense of an exchange of information) is understood here as a behavioural coupling of operationally closed systems perturbing each other (Qvortrup, 1993). This no longer involves a difference as cause of a difference, which presupposes a certain conmensurability between system and environment (or, in other words, an ontologization of the difference between both). It rather entails independent coupling changes (as part of systems' structural drift), becoming part of systems' horizon of operations and, therefore, becoming meaningful differences. Rather than being produced or made, differences, in that case, are found by the system.

«In the context of the autopoietical reproduction the environment exists as irritation, disturbance, noise, and it only becomes meaningful when it can be related to the system's decision-making connections. This is only the case when the system can understand which difference it makes for its decision-activity when the environment changes or doesn't change in one or the other respect. Such a difference which exists for the system in the environment and which for the system may imply a difference for the system itself, i.e. a different decision, in accordance with Gregory Bateson we would call information. As 'difference that makes a difference' information is always the system's own product, an aspect of the processing of decision and not a fact in the environment which exists independently of observation and evaluation. On the other hand the system cannot freely create information as its own product or let it be. The system is continuously perturbated by the environment, and with its decision-network it seeks out perturbations so as to transform them into information and

to use them as a guide for decision-making.» (Luhmann cit. in Qvortrup, 1993).

Ultimately, the two constructivist perspectives considered here link the observational problems of information to a conception of cognition that, inasmuch as it is assumed as part of its own condition of observation, becomes necessarily a kind of epistemology. In other words, for the constructivist perspective, cognition and epistemology overlap each other in the same operative principle:

«There is an external world which already follows from the fact that understanding can be made as a selfcontained operation; however, we do not have any direct access to the world. Understanding cannot reach the outsi de world without understanding. In other words, understanding is understanding as self-referential process». (Luhmann, 1990a:33)

That self-referential proposal of cognition articulated upon an endogenous conception of information forces to attend to the biological principles implicit in observational logics and ultimately poses a radical revision of the concept of communication.

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(JMA)

ENTROPY or AMOUNT OF INFORMATION (S. *entropía/ cantidad de información*, F. *entropie/ quantité d'information*, G. *Entropie/ Informationsgehalt*) [MTC] concept

The entropy of amount of information of a discreet information source, characterised by the probability p_j, of sending each of its symbols, j, is the statistical average:

$$H = -\sum_j p_j \log_2 p_j \text{ (bits)}$$

being bounded within the limits $0 \leq H \leq \log_2 N$, where N is the number of symbols.

In case the source might adopt various states i, being P_i the state probability, and $p_i(j)$ the probability of sending symbol j when the

source is in state i, then the entropy is defined as the average of the entropies of each state:

$$H = \sum_i P_i H_i = - \sum_{i,j} P_i p_i(j) \log_2 p_i(j) \text{ (bits)}$$

According to Floridi (2005), the entropy H might designate three equivalent quantities in the ideal case of a noiseless channel: 1) "the average amount of information per symbol produced by the informer"; 2) the "average amount of data deficit (Shannon´s uncertainty) that the informee has before inspection of the output of the informer"; 3) "informational potentiality".

Since the first two interpretations assume that a defined uncertainty corresponds to each symbol (whether it is in the emission or reception), it implies a certain tactical agreement regarding to the →*alphabet* or the informational game in which the agents are immersed. In both cases, the information can be quantified under the condition that the probability distribution can be specified.

Concerning the third interpretation, entropy might be understood in terms of a physical magnitude related to the amount of disorder in processes or systems conveying energy or information. The larger the entropy, the higher the number of physical states in which the system can be found, consequently, the more information it can refer to, or in other words, the specification of the state in which a certain system is requires more information as its entropy increases. Numerically, this is equivalent to the amount of information or data that has to be given in order to specify the state.

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(JMD)

F

FEEDBACK (S. *realimentación* / *retroalimentación*, F. *rétroaction*, G. *Rückkopplung*) [transdisciplinary, System theory, Control theory, Cybernetics] concept

It consists of feeding back the output of a circuit or system to its own input. Usually used in controlling the behaviour of systems, it can be found in the most complex systems such as: technical, economical, thermodynamical, biological or social ones. In the field of social groups or human organizations of functional type, "feedback" is used in the sense of sharing observations, concerns, proposals (especially in the opposite sense of normal circulation of the operating instructions or orders) to regulate the operation of the system toward its goals. Feedback systems are also called closed-loop systems.

This is one of the fundamental means considered by →*cybernetics* for the regulation, control, and evolution (specially in second-order cybernetics) of complex systems. Feedback can be divided into positive and negative depending on whether the feedback path of the system -from output to input- reinforces or counteracts the causes that create a change in the system output. In the study of stability of feedback electronic systems, Nyquist found the general conditions that such feedback should be met to ensure the stability of the system (based on mathematical models of the behaviour of both the open-loop system -without feedback- and the feedback subsystem).

Positive ~ refers to the situation in which the system output -in response to a change in its input- tends to increase the variation in the same direction. Obviously, this does not lead to stability; nevertheless, it serves to explain the evolution of a system towards a new equilibrium state in which it can be stabilized. This type of feedback plays a key role in morphogenesis, growth and organic development and, in general, in processes which are characterized by quick changes in their behaviour with respect to their initial conditions.

Negative ~ refers to the situation in which the system output -in response to a change in its input- aims at reducing the variation; therefore, operating in an opposite direction to the change of input. In this case the feedback is applied to prevent the instability of the system due to external changes -which is referred as *homeostasis*, or maintenance of the equilibrium-accounting for control of organic behaviour and the possibility of a linear operation of the system. Such stability with regard to the external changes enables a teleological behaviour of the system (Rosenblueth 1943).

Bipolar ~ refers to the situation in which the system output -in response to a change in its input- can either increase or decrease such variation (depending on both the system state, and the variation of the input).

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(BH –ed.-; JMD, BH)

FLOKSONOMY (S. *folksonomía*, F. *folk-sonomie*, G. *folksonomien*) [social web] concept

Folksonomies are a set of terms (called tags) collected from the Natural Language. These tags are used to describe web resources semantically.

Context. This term belongs to the Social Web vocabulary. In social tagging, users describe their own or external social web resources with tags.

Advantages:

— Easy to use. Folksonomies are a simple and friendly solution to describe resources.
— Cheap. Everybody is able to employ tagging, without a prior training in either indexing techniques or controlled vocabularies.
— The vocabulary fits the resource, even when the resource is quite specific. The user can describe the resources with his own terms. Once the term is used, the folksonomy includes the term as a tag.

Disadvantages:

— Tags are ambiguous due to polisemy and synonyms. Frequently, systems just allow assigning simple terms instead of more specific compound terms; therefore increasing ambiguity.
— Tags might have orthographical and typing errors.
— Tags are arbitrarily assigned without an indexing policy.
— There might be no semantic relationship between terms.

Origin. Term coined by Thomas Van Der Wal, merging the terms folk (popular) and taxonomy.

Examples:

— *Flicker*. Application to manage, share and retrieve photos on line. Every user describes their own photos with relevant tags.
— *Youtube*. Application to share video online.
— *Del.icio.us*. Application to tag web pages. Users can index other web pages.

Folksonomies and ontologies. The goal of **Folksontologies** is to build an ontology from a folksonomy. This implies linking every tag from a folksonomy with semantic relationships. This allows to achieve shared conceptualizations used by users.

Related Resources

— Flicker: http://www.flickr.com
— Youtube: http://www.youtube.com
— Del.icio.us: http://delicious.com

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(JAM –ed–; EC, JML)

FOTOBLOGS AND ADOLESCENTS (S. *fotoblogs y adolescentes*, F. *fotoblog et les adolescents*, G. *Fotoblogs und Jugendliche*) [Information Society, ICT] problem

Adolescents have grown up in an information society where they have not needed to be 'educated' in order to learn and employ the norms of use of the internet; rather, they have developed the norms and have adapted them to their own needs. Indeed, today's youth do not use the term "new technology" when they talk about issues related to computing. To them, the net is nothing new.

The new media provide adolescents with a context that allows them to create signs of identity. Most adults are unaware of the strategies, practices and codes commonly used in chat rooms, instant messaging, SMS texting on mobile phones or on blogs that young people routinely use in their day to day lives. Use of this technology is not just part of their lives, but a way of life. They are media which not only inform the users who surf the internet. Rather, the media shapes users and encourages them to create strategies and attitudes to

communicate with their peers from different virtual contexts.

From these means of communication, the adolescent is projecting a representation of himself in which he reveals not only his personality, his character, how he feels or what he likes, but also reflects who he would like to be. In this way, the photoblog is a place where connections are established with the peer group that the adolescent wishes to interact with and belong to. With this in mind, the adolescent goes about creating and shaping his identity. The interaction between subjects with similar interests, ages and tastes, leads to the construction of their selves through the image, through the interface. Thus, the photoblog becomes a space of socialization.

The adolescent, through the discourse established within the photoblog, creates a narrative; one which is understood as a mental construction of reality. As human beings, we seek meaning in our experiences through a process of using a language that we, as well as others, understand. This language can be verbal, textual, visual or physical. According to Bruner, the meaning we give to our experience and to that of others depends on the public and shared meanings of our interaction as members of a culture. Today, it is a culture comprised of two generations, one which has grown up with computers and another that has had to adapt to them. Young people have adapted media computers to their interests, whereas their predecessors rather adapted to them.

We live in an information and knowledge society where interests of different age and gender groups and social classes, concern hobbies and ideas that may converge as well as diverge. The media expose, more clearly, the characteristics of each group. Roxana Morduchowicz (2004) says that media construct myths and stories through which individuals constitute a common culture. Thus, the identities of young people are drawn in the intersection of written text, electronic images and popular culture. It is true that we live in an environment that is

defined by the presence of a plurality of cultures; with this statement we do not refer to the reality of the phenomenon of immigration, but to the multiplicity of subcultures [1], as, for instance, the ones expressing adolescents' own interests.

Adolescent's use of photoblogs shows how the relationship between user and media has changed due to the transformations introduced by the Internet and the processes of digitalization. If the first theoretical models of mass communication conceive this relationship as linear and unidirectional, most current theories emphasize the active role of the receiver. Thus, we have moved beyond the so-called dominant paradigm's main theory of how the media influences us, to being preoccupied with "what do people do with media?", or even beyond that to "what media do people create?".

Present day consumers not only actively use the media for the purpose of satisfying psychological or emotional needs, as the Theory of uses and gratifications has stressed, but additionally people have become producers of media and audiovisual content. The resulting change is not solely based, even on a primordial level, on technological innovation per se, but in the creation of new socially recognized communication practices (See "Las industrias audiovisuales y los nuevos medios" in Durán y Sánchez 2008). From our point of view, the use of photoblogs by adolescents demonstrates this turning point that new technologies have generated. It is precisely this quality we wish to demonstrate when we characterize photoblogs as a symbolic creative space through which an adolescent defines himself as a subject via interaction with others by means of the aesthetic use of images.

Thus, adolescents use photoblogs with the intention of creating new communication protocols that allow them to express themselves not as consumers but as creators. It is about creating a space that goes beyond posting pictures and comments in order to establish an environment that reveals their relationships,

moods, tastes, interests, etc. integrated into their daily lives. It is an environment that enhances the subject's creativity in an entertaining way, either in the pursuit of the most fitting images or in the formalization of original on-screen writing. An interesting characteristic of photoblogs is that they communicate that which is seen. All of this is done to establish a symbol of group identity to which the teenager wishes to belong. We say "wishes" because, with every change, she is building her identity by communicating with her peers. Marc Augé (1996) affirms that individuals acquire existence only through the relationships among them. In the case of photoblogs, the teenager relates to others abiding by some rules of use which, although not explicitly codified, can be guessed through the study of the different forms of representation.

On the other hand, the messages produced by teenagers by means of photoblogs cannot be translated into another form of communication because the medium offers resources and strategies of its own, which allow the subjects to convey ideas and feelings graphically through the representation on the screen.

On photoblogs, the choice of images combined with texts written in a particular way constitute a new way of interacting; to express, proclaim, question or answer and cannot be translated into another mode of communication because the nature of the environment facilitates a kind of speech that is difficult to translate into spoken language and gestures. Perhaps we can consider this medium as one of the extensions of the body which McLuhan has spoken about (1996); the photoblog is not only a means of communication, but rather it is a glimpse of a new way of relating between people who live in different contexts.

The use of photoblogs allows for strategies and forms of communication that define it as a context in which feelings or ideas are expressed through visual forms that determine the nature of the message. Hence, the message could not be gestated in a different way and obtain the same reaction in the receptor. In

the edition of these visual forms, there is a decorative aesthetic intentionality that forms part of the content of the message. The representation of texts, together with the images themselves, confers a new communicative sense to words.

This article doesn't pretend to make value judgments regarding the use of photoblogs by adolescents. It just wants to present a social reality and indicate some aspects that reflect the so-called digital generation gap. Carles Feixa, among other authors, talks about the generation ac (after computer) and bc (before computer). While in the past, generational gaps were marked by historical events or by music ruptures, today, the evolution of digital media marks the distance between generations.

Young people who have grown in digital environments are not only more skilful and effective than their parents in the exploitation of these environments, but also show differences in their ways of accessing information and communication in general. The difference relies not only in the fact that one generation is more passive and the other commits to interactivity, but in that these processes are changing traditional cognitive structures and schemata.

Applying the Uses and Gratifications theory, cited in the previous paragraph, we would say that the medium is defined by the user. For example, the use that adolescents and their parents make of mobile phones can make us conclude that we are in front of a different device. While the former are always connected through brief and trivial particularized messages or photographic snapshots, adults simply stick to the fixed phone's customary routines.

The same happens with the Web. Vilches speaks of "space migrants claiming the right to live in the territory of a connected civilization" (2001:36). This represents a paradigm shift in relationships and in the construction of the social. Psychologists and sociologists study the

consequences that can result from being continually "plugged in". However, any change or rupture always produces arguments pro and con. And now we are witnessing, in regard to the use young people make of computers, the same sort of debate that took place some time ago concerning television. However, there is a fundamental difference that we mentioned at the beginning concerning these two changes, while the former TV addicts were passive, current messenger abducted youngsters act and create.

In this so-called global society, immersed in what Toffler called The third wave, new systems of symbols and codes have emerged, characterized by the use of image. Young people receive and send orders and messages through visual media. The photoblog is one of these spaces in which the image becomes a new mode of communication. And we are not referring only to iconic images themselves, but also to the many ways of producing written texts that are displayed on the interface. Such "productions" are, in many cases, incomprehensible and even insipid for adults, but one might as well ask them how those spiral notebooks and diaries they wrote and decorated when they were teenagers "felt" at the time, and how they see them now. The references and archetypes were different, but the need for "constructing one's self" was the same.

A different approach would consider these spaces as an expression of uncommitted and merchandised low culture, full of banalities; however, we must insist that it is the user who makes the medium. There are, in the web, multiple collective projects with an altruistic, creative or informative character, induced by young people who, precisely, strive to avoid the systems of economic exploitation in which we are immersed.

To conclude, we say that adolescents' use of photoblogs is part of the divers elements and actions that help them build symbolic forms in order to make sense of their own experience and of their relationship with their environment. Young subjects simply take advantage of digital media to suit their interests and needs. A space which was initially conceived as a means to "hang" amateur photos has become a medium for the exchange of opinions and wishes, and the construction of personality.

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(LS –ed.-; SBB, JMD)

FUZZY LOGIC (S. *lógica borrosa*, F. *logique floue*, G. *Fuzzylogik, verschwommene Logik*) [transdiciplinary, system theory, control theory, epistemology, semantics] theory

Contents.— *1) On fuzziness: thinking, language and information, 2) Introduction to fuzzy set theory, 3) Classic Set Theory (a. Membership Functions, b. Operations between sets), 4) Fuzzy Set Theory (a. Fuzzy sets, b. Operations between fuzzy sets, c. T-Norms and S-Norms), 5. Fuzzy Systems (a. Fuzzy Relations, b. Composition of Relations, c. Approximate Reasoning)*

"[...] Is a fuzzy concept a concept at all? - Is a photograph that is not sharp, a picture of a person at all? Is it even always an advantage to replace a picture that is not sharp by a sharp one? Isn't one that isn't sharp often just what we need?" (Wittgenstein, L., *Philosophical investigations*, §71, 1958).

1. On fuzziness: thinking, language and information. "Fuzziness" is used as a visual metaphor of vagueness, inaccuracy, in opposition to sharpness or well-definiteness.

Unlike the traditional endeavour in science and philosophy for avoiding vagueness (consider, for instance, the centrality of "clearness" and "distinction" in Descartes and by extension in modern science and philosophy), there is a growing awareness of the fact that our knowledge of reality (or the information being conveyed or received about a concrete reality) contains a constitutive vagueness depending on the pragmatic situation in which this knowledge or information is immersed. The fundaments of this certainty can be found in the principles of statistical and quantum mechanics (→*holographic principle*), mathematics (→*incompleteness*) or scientific methodology (Pointcaré 1907).

In opposition to a negative assessment of vagueness, fuzzy logic has started to be considered as one of the fundamental features of cognitive systems, language and knowledge, allowing them to achieve a plasticity and dynamism, which are essential for the adaptation to changing environments. Thus, the robustness of the cognitive and linguistic system -far from

being damaged by its fuzzy or blurred character- is rooted in such fuzziness (Kosko 1995, Pérez-Amat 2008).

Intending to give an account of the way of human reasoning, which is simply inaccurate, flexible, analogical…, fuzzy logic has been developed as a logical calculus, embracing the classical one -though distancing from its approaches, particularly in its way of rigid reasoning, which has been a fundamental character of mathematics since platonic times (Ferrater Mora 1994, 409s). This logical calculus has been successfully employed in both artificial intelligence and the so-called fuzzy control of industrial application, and it has been posed as a basis of a quantitative approach to semantic information (Pérez-Amat 2008).

But the fuzziness that can be ascribed to information does not only concern the semantic level, which depends upon the more or less contingent characteristics of human reasoning. On the contrary, the information that can be obtained from an **observed reality** is intrinsically fuzzy: the signals that can be received from some object are ultimately wave phenomena, which can only convey –due to its constitutive nature- a finite number of data over a bi-dimensional or superficial domain bounding the observed objects. That is, the whole wave phenomena outside the sources can be determined by a discrete distribution over a surface surrounding the object, therefore the dimension of the wave distribution in the surrounding space cannot be bigger than the dimension corresponding to such 2-dimensional discrete distribution. Thus, although the real extension of the observed object is 3-dimensional (volumetric) and it might be continuous, just a blurred projection of the observed object over a bounding surface can be achieved based upon the observation of the wave phenomena. In other words, the information that can be gathered about something being observed is constitutively fuzzy (Díaz Nafría 2008; Díaz Nafría & Pérez-Montoro 2010a, 2010b).

2. Introduction to fuzzy set theory. The fuzzy set theory was initiated by Zadeh in the early 1960s (1964, 1965) (see Bellman et al. (1964)). In 1951, Menger (1951) explicitly used the fuzzy relation "max-product" but with probabilistic interpretation.

Since 1965, fuzzy set theory has been developed considerably by Zadeh and many other researchers. This theory was started to be implemented in a wide range of scientific environments.

There have been many books on fuzzy set theory as the mathematically one by Negoita and Ralescu (1975). There are also two research collections edited by Gupta et al. and Zadeh et al. (1975) and (1977).

Apart from the excellent research works of Zadeh, other introductory articles are those presented by Gusev and Smirnova (1973), Ponsard (1975), Kandel and Byatt (1978), Chang (1972), Gale (1975), Watanabe (1969), and Aizerman (1977).

There are several literature citations on fuzzy sets written by De Kerf (1975), Kandel and Davis (1978), Gaines and Kohout (1977) and Kaufmann (1980).

Mathematical formulas of the fuzzy sets theory will be presented in the following sections (§ 3, § 4, § 5). The basic definitions of classical sets, and the definitions and types of fuzzy sets, are revised. A detailed explanation of the operations between fuzzy sets, rules and norms-t-s are also carried out. The properties and the composition of fuzzy relations are reviewed. The characteristics and approximate reasoning are analyzed.

3. Classic Set Theory. A classical set is a collection of objects of any kind. What is called set theory was proposed by Georg Cantor (1845-1918), a German mathematician. In set theory, the set and the element are primitives. They are not defined in terms of other concepts. Let A be a set, "x $\in$ A" means that x is an element in the set A and "x $\notin$ A" means that x does not belong to the set A. The set A is

completely specified by the elements it contains. For example, there is no difference between a set which consists of 2, 3, 5 and 7 elements and a set of all prime numbers under 11.

Let **X** be a universe of discourse in which the set A is a subset, i.e.

$$A \subseteq \mathbf{X} \tag{1}$$

In the classical set theory, any element x which belongs to **X**, belongs or not to the subset A clearly and undoubtedly, without any other option apart from these two ones.

Membership or not of an arbitrary element x to a subset A is given in most cases by checking whether or not a predicate that characterizes the subset A and gives rise to a bipartition of the universe of discourse X.

a) Membership Functions. The concept of belonging or not of an element to a set A can be expressed numerically by membership function, also sometimes called characteristic function. This function assigns a binary bit (1 or 0) to each element x of the universe of discourse as x belongs or not to the set A

$$\mu_A(x) = \left\{ \begin{array}{ll} 1 & \text{when } x \in A \\ 0 & \text{when } x \notin A \end{array} \right. \tag{2}$$

any set A $\subset$ X can be defined by the pairs which form each element x of the universe and its membership function, as follows:

$$A = \{(x, \mu_A(x)) \forall x \in \mathbf{X}\} \tag{3}$$

b) Operations between sets. Given any two sets A and B included in X, it is possible to define new sets from them or, which is the same, it is possible to operate with them. The basic operations between sets are described as follows:

— *Intersection*: is denoted by A $\cap$ B and is defined as the set formed by those elements of X belonging to A and B simultaneously:

$$x \in A \cap B \text{ if } x \in A \text{ y } x \in B \tag{4}$$

— *Union*: it is the set formed by those elements that belong to A or B, or both simultaneously. It is denoted by A ∪ B

$$x \in A \cap B \ \textit{if} \ x \in A \ y \ x \in B \qquad (5)$$

— *Complement*: The complement of A is denoted by Ā, and consists of all elements of X that do not belong to A

$$x \in \overline{A} \ \textit{if} \ x \notin A \qquad (6)$$

$$\mu_{\overline{A}}(x) = 1 - \mu_A(x) \qquad (7)$$

The three operations are shown in the following table.

$\mu_A(x)$	$\mu_B(x)$	$\mu_{A \cap B}(x)$	$\mu_{A \cup B}(x)$	$\mu_{\overline{A}}(x)$
0	0	0	0	1
1	0	0	1	0
0	1	0	1	1
1	1	1	1	0

Table 1: Operations between classical sets

4. Fuzzy Set Theory. In fuzzy set theory, classical sets are called crisp sets in order to distinguish them from fuzzy sets. Let A be a classical set defined in the universe X, then for any element x in X, x ∈ A or x ∉ A. In fuzzy set theory this property is widespread, therefore, in a fuzzy set A, it is not necessary that x ∈ A or x ∉ A.

In recent years several definitions have been introduced to present the generalization of property membership (Dubio 1987), (Pawlak 1985), (Shafer 1976), but it seems that fuzzy set theory is the most intuitive among the other theories and existing theorems.

The generalization is as follows.

a) Fuzzy Sets. We can define the characteristic function uA: X ⟶ (0,1) for any classic set as shown in equation (2). In fuzzy set theory, the characteristic function is generalized so that the membership function assigns a value for each x ∈ X in the interval [0,1] instead of two-element set (0,1). The set is based on this extended membership is called fuzzy sets.

Definition 1. Universe of Discourse is defined as the set X of possible values that can take the variable x. It can be represented as:

$$\mathbf{X} = \{x\}$$

Definition 2. The membership function uA (x) of a fuzzy set A is as follows:

$$\mu_A : X \rightarrow [0, 1] \qquad (8)$$

Thus, any element x in X has degree of membership $\mu_A(x) \in [0,1]$. A is completely determined by:

$$A = \{(x, \mu_A(x) \mid x \in X\} \qquad (9)$$

Example 1. Suppose someone wants to describe a class of fast land animals like ostrich, cheetah, horse, spider, man, tortoise and hare. Some of these animals definitely belongs to this class, while others like the tortoise or the spider do not belong. But there is another group of animals where it is difficult to determine whether they are fast or not. Using a fuzzy set, the fuzzy set for fast animals is:

(Cheetah, 1), (Ostrich, 0.9),
(Hare, 0.8), (Gazelle, 0.7), (Cat, 0.4)　(10)

i.e., the hare belongs with grade of 0.8, the gazelle with grade of 0.7 and the cat with 0.4 grade to the class of fast animals.

If we assume that C is a classical finite set $(x_1, x_2, ..., x_n)$, then an alternative notation is

$$C = x_1 + x_2 + \cdots + x_n$$

where + is an enumeration.

A part from it, Zadeh proposed a more convenient notation for fuzzy sets.

Example 2. The set of all the fast animals, in equation (10), is described by:

1/Chetah + 0.9/Ostrich + 0.8/Hare +
0.7/Gazelle + 0.4/Cat.　(11)

that is, one may describe the fuzzy set in equation (9) is as follows:

$$A = \mu_A(x_1)/x_1 + \mu_A(x_2)/x_2 + \ldots + \mu_A(x_n)/x_n$$

$$= \sum_{i=1}^{n} \mu_A(x_i)/x_i$$

(12)

where the symbol of division is only a separator of sets of each pair, and the sum is the union operation between all elements of the set. The + fulfills the a / x + b / x = max (a, b) / x, i.e., if the same item has two different degrees of membership 0.8 and 0.6, then the membership degree is 0.8. Any discrete universe can be written as follows:

$$A = \sum_{x \in X} \mu_A(x)/x$$

(13)

but when X is uncountable or continuous, the above equation is described as:

$$A = \int_X \mu_A(x)/x$$

(14)

Equations (12) and (14) can written with the classical notation as follows:

$$\{\mu_A(x)/x \mid x \in X\}$$

(15)

Example 3. Figure 1 shows some fuzzy sets defined in the universe of discourse Age. The fuzzy set "young" represents the membership degree with respect to the parameter youth where individuals of every age can have.
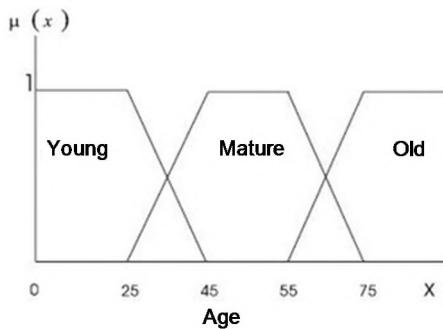

Figure 1: An example of fuzzy sets

It can be seen that the fuzzy sets overlap, so that an individual might have a degree of membership in two groups: "young" and "mature", indicating that it has qualities associated with both sets. The membership degree of x

in A , as noted above, is represented by $\mu_A(x)$. The fuzzy set A is the union of the degrees of membership for all points of the universe of discourse X, which can also be expressed as:

$$A = \int_x \mu_A(x)/x$$

(16)

Under the notation of fuzzy sets, $\mu_A(x)/x$ is an element of set A. The operation $\int_x$ represents the union of fuzzy elements $\mu_A(x)/x$. The universes of discourse with discrete elements use the symbols + and Σ to represent the union operation.

$$\boldsymbol{Young} = \int_0^{25} 1 + \int_{25}^{45} (2.25 - \frac{X}{20})$$

(17)

It is commonly convenient to define a fuzzy set with the help of some formula so that, for example, all "young" could be expressed as:

Definition 3. The function $\Gamma: X \rightarrow [0,1]$ is a function of two parameters defined as follows:

$$\Gamma(x, \alpha, \beta) = \begin{cases} 0 & x < \alpha \\ (x - \alpha)/(\beta - \alpha) & \text{when} \quad \alpha \le x \le \beta \\ 1 & x > \beta \end{cases}$$

(18)

This function can be seen in fig. 2

Figure 2: An example of the function Γ

Definition 4. Let A and B be two fuzzy sets defined respectively on the universe X and Y, and is the fuzzy relation R defined on X × Y. The *support* of a fuzzy set A is the classical set containing all the elements of A with the membership degrees that are not zero. This is defined by S (A).

The support of a fuzzy set A is defined as follows:

$$S(A) = \{x \in X \mid \mu_A(x) > 0\}$$

(19)

Definition 5. A fuzzy set A is *convex* if and only if X is convex and

$$\forall x, y \in X \; \forall \lambda \in [0,1] \mid \mu_A(\lambda x + (1-\lambda)y) \geq$$
$$\geq min(\mu_A(x), \mu_A(y)) \qquad (20)$$

Definition 6: The height of a fuzzy set A on X, denoted by Alt (A) is defined as:

$$Alt(A) = \sup_{x \in X} \mu_A(x) \qquad (21)$$

A fuzzy set A is called normal, if Alt (A) = 1, is subnormal if Alt (A) <1.

In fuzzy control theory, it is usual to deal only with convex fuzzy sets.

Definition 7. Given a number $\alpha \in [0,1]$ and a fuzzy set A, we define the *a-cut* of A as the classical set A_α which has the following membership function:

$$\mu_{A\alpha}(x) = \begin{cases} 1 & \text{when } \mu_A(x) \geq \alpha \\ 0 & \text{in any other case} \end{cases} \qquad (22)$$

In conclusion, the α-cut consists of those elements whose membership degree exceeds or equals the threshold α.

4.2 Operations between Fuzzy Sets. Operations such as equality, and the inclusion of two fuzzy sets are derived from classical set theory. Two fuzzy sets are equal if each element of the universe has the same degree of membership in each one of them. The fuzzy set A is a subset of fuzzy set B if every element of the universe has a membership degree lower in A than in B.

Definition 8. Two fuzzy sets are *equal* (A = B) if and only if

$$\forall x \in X : \mu_A(x) = \mu_B(x) \qquad (23)$$

Definition 9. A is a *subset* of B (A ⊆ B) if and only if

$$\forall x \in X : \mu_A(x) \leq \mu_B(x) \qquad (24)$$

The fuzzy sets can be operated with each other in the same way as the classical sets, since the former is a generalization of the latter. The interpretation with fuzzy sets is not as simple as traditional sets because they are used the characteristics of membership functions. It is possible to define operations like union, intersection and complement using the same membership functions. Zadeh proposed the following (Zadeh 1965):

Definition 10. The intersection between two fuzzy sets is represented as follows:

$$\forall x \in X : \mu_{A \cap B}(x) = min(\mu_A(x), \mu_B(x)) \quad (25)$$

Definition 11. The *union* between two fuzzy sets is represented as follows:

$$\forall x \in X : \mu_{A \cup B}(x) = max(\mu_A(x), \mu_B(x)) \quad (26)$$

Definition 12. The *complement* of a fuzzy set is represented as follows:

$$\forall x \in X : \mu_{\overline{A}}(x) = 1 - \mu_A(x) \qquad (27)$$

Definition 13. The product of two fuzzy sets A and B is defined as

$$\mu_{A.B}(x) = \mu_A(x).\mu_B(x) \; \forall x \in X \qquad (28)$$

Definition 14. The sum of two fuzzy sets A and B is defined as

$$\mu_{A+B}(x) = \mu_A(x) + \mu_B(x) \; \forall x \in X \qquad (29)$$

Definition 15. a function n: $[0,1] \rightarrow [0,1]$ is said that it is a *negation function* if and only if it verifies the following properties:

1) n(0) = 1, n(1) = 0 (boundary condition)

2) n(x) $\leq$ n (y) if x $\geq$ y (monotone)

It also says that n is strict if and only if

3) n(x) is continuous

4) n(x) <n (y) if x> y $\forall$ x, y $\in$ [0,1]

and is involutive if and only s

5) n(n(x)) = x $\forall$ x $\in$ [0,1]

c) T-Norms and S-Norms. In fact, the above definitions are quite arbitrary and could have been defined in many other ways. This includes considering more other general definitions for the operations between fuzzy sets in which they only have the same properties,

similar to those seen in the classical sets theory. At present it is considered correct to define the intersection operator by any application t-norm and the union operator by any application s-norm (Schweitzer and Sklar 1961, 1963, Weber 1983), which are non-decreasing functions, so increasing one of the sets, also imply an increase its intersection or union.

Definición 16. triangular Norm

A *triangular norm* or *t-norm* is a function t: $[0,1] \times [0,1] \rightarrow [0,1]$ which verifies the following properties:

— It is nondecreasing in each argument:

If $x \leq y$ and $w \leq z$ then $t(x, w) \leq t(y, z)$

— Commutativity

$t(x, y) = t(y, x), \forall x, y \in [0,1]$

— Associativity

$t(t(x, y), z) = t(x, t(y, z)), \forall x, y, z \in [0,1]$

— the boundary conditions are satisfied

$t(x, 0) = 0, t(x, 1) = x, \forall x \in [0,1]$

— t is an Archimedean norm if and only if

$t(x, y)$ is continuous

$t(x, x) < x \ \forall \ x \in (0,1)$

And an Archimedean t-norm is strict if and only if

$t(x',y') < t(x)$ if $x' < x, y' < y \ \forall x',y',x,y \in (0,1)$

The t-norms are used to express the intersection of fuzzy sets:

$$\mu_{A \cap B}(x) = t(\mu_A(x), \mu_B(x)) \qquad (30)$$

It can be said that the min operator is a t-norm.

Definition 17. Triangular conorm:

A *triangular conorm* is also called *t-conorm* or *s-norm*, is an application s: $[0,1] \times [0,1] \rightarrow [0,1]$ that satisfies the following requirements:

— s is nondecreasing in each argument

— Commutativity

— Associativity

— Boundary conditions

$$s(x, 0) = x \ , \ s(x, 1) = 1, \ \forall x \in [0, 1] \quad (31)$$

The s-norms are used to express the union of fuzzy sets:

$$\mu_{A \cup B}(x) = s(\mu_A(x), \mu_B(x)) \qquad (32)$$

It can be concluded that the max operator is a t-conorm.

— s is an Archimedes conorm if and only if:

$s(x, y)$ is continuous

$s(x, x) > x \ \forall \ x \in (0,1)$

And an Archimedean t-conorm is strict if and only if

$s(x',y') < s(x,y)$ si $x' < x, y' < y \ \forall x',y',x,y \in (0,1)$

d) Properties of Fuzzy Sets. The laws and properties that fufill the classical sets are not always followed in the case of fuzzy sets. The following sections examine what laws verify the fuzzy sets and what not:

— Commutative property: always verified, because the t-norms s-norms are commutative by definition.

— *associative Property*: is also verified as the t-norms s-norms are associative.

— *Laws of idempotency*: are fufilled. The minimum and maximum are chosen as operators for intersection and union, respectively.

— *Laws of absorption*: they are also met if the minimum-maximum pair are selected. This not true with other norms.

— *Distributive property*: it is also true for the minimum and maximum, but not for other norms.

— *minor and major Property*: always fulfilled due to the last property t-norms and s-norms.

— *Complement Involution*: is satisfied if we define $\mu \bar{A}(x) = 1 - \mu A(x)$ since then:

$$\mu_{\bar{A}}(x) = 1 - \mu_A(x) =$$
$$= 1 - (1 - \mu_{\bar{A}}(x)) = \mu_{\bar{A}}(x) \qquad (32)$$

— *De Morgan's laws*: its fulfillness is guarantized if the selected t-norms and s-norms are derived from each other: t (x, y) = 1-s (1-x ,1-y).

— *complementary Laws*: they are not verified in general. It is perhaps the clearest result to introduce the concept of fuzziness in the sets.

5. Fuzzy Systems

a) Fuzzy Relations. As seen before, all the operations of union, intersection and complement, operate in a single universe of discourse. However, the Cartesian product allows the product of universes of discourse.

Cartesian Product. Let X and Y be any two universes of discourse. A fuzzy relation R between X and Y is defined as a fuzzy set whose universe is the Cartesian product $X \times Y$. That is:

$$R = \{((x,y),\ \mu_R(x,y)) \mid (x,y) \in X \times Y\} \quad (33)$$

$$\mu_R : X \times Y \to [0,1] \quad (34)$$

If A_1 and $A_2 \subset X \subset Y$, and if the Cartesian product of A_{12} and A is defined as:

$$\mu_{A_1 \times A_2}(x,y) = min\{\mu_{A_1}(x), \mu_{A_2}(y)\} \quad (35)$$

It can also be expressed as:

$$\mu_{A_1 \times A_2}(x,y) = t\{\mu_{A_1}(x), \mu_{A_2}(y)\} \quad (36)$$

Definition 18. Let X and Y be continuous *universes of discourse*. Then the function

$$\mu_R(x,y) : \quad X \times Y \to [0,1] \quad |$$

$$R = \int_{X \times Y} \mu_R(x,y)/(x,y) \quad (37)$$

is a binary fuzzy relation on $X \times Y$. If $X \times Y$ are discrete universes, then

$$R = \sum_{X \times Y} \mu_R(x,y)/(x,y) \quad (38)$$

The integral denotes the sets of all tuples μ_R (x, y) / (x, y) on $X \times Y$. It is also possible to express Equation (37) with $\int_X \int_Y \mu_R(x,y)/(x,y)$, ,i.e., with double integral.

Definition 19. Let R and S be binary relations defined on $X \times Y$. The *intersection* of R and S is defined by:

$$\forall(x,y) \in X \times Y : \mu_{R \cap S}(x,y) =$$
$$= min(\mu_R(x,y), \mu_S(x,y)). \quad (39)$$

T-norm can be used rather than the minimum.

Definition 20. The union of R and S is defined by:

$$\forall(x,y) \in X \times Y : \mu_{R \cup S}(x,y) =$$
$$= max(\mu_R(x,y), \mu_S(x,y)). \quad (40)$$

S-norm can be used rather than the maximum.

Definition 21. A *projection* of a fuzzy relation μ_R: $X_1 \times ... \times X_n \to [0,1]$ on the universe of discourse X_i, is defined as

$$proy_{x_i} R(x_1, \ldots, x_n) =$$
$$= \sup_{\forall x_i \in X_i} \mu_R(x_1, \ldots, x_n) \quad (41)$$

b) Composition of Relations. Let R be a fuzzy relation in the product $X \times Y$ and S forms another relationship in $Y \times Z$.

Definition 22. The *sup-min composition* of these two relations, denoted by R ° S, is defined as the fuzzy relation in $X \times Z$ whose membership function is:

$$\mu_{R \circ S}(x,z) = \sup_{y \in Y}[min\{\mu_R(x,y), \mu_S(y,z)\}] \quad (42)$$

Definition 23. The *inf-max composition*, denoted by $R \times S$, is defined as:

$$\mu_{R \otimes S}(x,z) = \inf_{y \in Y}[max(\mu_R(x,y), \mu_S(y,z))] \quad (43)$$

Definition 24. The *sup-product composition* as fuzzy relations in $X \times Z$ whose membership function is defined as:

$$\mu_{R.S}(x,z) = \sup_{y \in Y}[\mu_R(x,y).\mu_S(y,z)] \quad (44)$$

If we generalize the minimum and the product by a t-norm and the maximum by a s-norm, respectively, the compositions are obtained sup-t and inf-s:

$$\mu_{R \circ S}(x,z) = \sup_{y \in Y}[t(\mu_R(x,y), \mu_S(y,z))] \quad (45)$$

c) Approximate Reasoning. Unlike classical logic, in fuzzy logic, reasoning is not precise, but it occurs in an approximate manner. This means that one can infer a consequent although the rule antecedent is not completely verified (*Approximate Reasoning*). The higher the degree of compliance of the antecedent of the rule, the more approximate to the original rule the consequent part will be. The approximate reasoning is generally summarized, by extension of classical reasoning in the forms of "generalized modus ponens" and "generalized modus tollens.

premise 1: Premis of the rule:

x IS A*

premise 2: rule:

IF x IS A THEN y IS B

Consequent: y is B*

where A, B, A* and B* are fuzzy sets defined on the universes of discourse X, Y with membership function $\mu_A(x)$, $\mu_B(y)$, $\mu_A^*(x)$ and $\mu_B^*(y)$ respectively. This is the *generalized modus ponens*, which is reduced to the classical *modus ponens* when A = A* and B = B*.

The function of involvement is represented by a fuzzy relation in X × Y: R = A → B

$$\mu_{A \to B} : X \times Y \to [0,1] \qquad (47)$$

This function can be defined in several ways. For example,

1) *Mamdani Implication*: With respect to fuzzy control this Implication is the most important. Its definition is based on the intersection operation as described above,

$$\mu_{A \to B}(x,y) = min(\mu_A(x), \mu_B(y))$$
$$\forall x \in X, \quad \forall y \in Y \qquad (48)$$

that can be represented as a t-norm

$$\mu_{A \to B}(x,y) = t(\mu_A(x), \mu_B(y))$$
$$\forall x \in X, \quad \forall y \in Y \qquad (49)$$

2) *Zadeh Implication*: The most widespread implication. It firstly solves *if A then B*, if not A

then C and then take A → B as a special case where C coincides with its universe of discourse,

$$\mu_{(A \to B) \cup (\bar{A} \to C)}(x,y)$$
$$= s(t(\mu_A(x), \mu_B(y)), t(n(\mu_A(x)), \mu_C(y))) \qquad (50)$$
$$\forall x \in X, \quad \forall y \in Y$$

which can be written as

$$\mu_{A \to B}(x,y) = s(t(\mu_A(x), \mu_B(y)), n(\mu_A(x)))$$
$$\forall x \in X, \quad \forall y \in Y \qquad (51)$$

Finally, the conclusion B * is a fuzzy set B *= A * ∘ (A → B) can be evaluated by a generalization of Modus Ponens proposed by Zadeh:

$$\mu_{B^*}(y) = \mu_{A^* \circ R}(y) = \sup_{x \in X}[min(\mu_{A^*}(x),$$
$$\mu_R(x,y))], \quad \forall y \in Y \qquad (52)$$

or

$$\mu_{B^*}(y) = \mu_{A^* \circ R}(y) =$$
$$= \sup_{x \in X}[t(\mu_{A^*}(x), \mu_{A \to B}(x,y))], \quad \forall y \in Y \qquad (53)$$

i.e.,

$$\mu_{B^*}(y) = \sup_{x \in X} t(\mu_{A^*}(x), s(t\mu_A(x), \mu_B(y)),$$
$$, n(\mu_A(x)))) \quad \forall y \in Y \qquad (54)$$

A more general case is that a system composed of r_1 rules, each of which is of the form *IF x IS A^{i_1} THEN y IS B^{i_1}*

$$\mu_{R^{i_1}}(x,y) = \mu_{A^{i_1} \times B^{i_1}}(x,y)$$
$$= t(\mu_{A^{i_1}}(x), \mu_{B^{i_1}}(y)) \quad \forall x \in X, \quad \forall y \in Y$$
where $i_1 = \{1, \ldots, r_1\}$ \qquad (55)

$$\mu_R(x,y) = s(\mu_{R^1}(x,y), \ldots, \mu_{R^{r_1}}(x,y))$$
$$\forall x \in X, \quad \forall y \in Y$$

Finally we analyze the case of rules with two antecedents. Let A, B and C defined fuzzy sets in X, Y and Z respectively. The rules are represented as follows:

premise 1: Premisa of the rule:

x IS A* E and IS B*

premise 2: rule:

$$\text{SI x IS } A^{i1} \text{ E y IS } B^{i2} \text{ THEN z IS } C^{i1\,i2}$$

Consequent: z is C^*

$$\mu_{R^{i_1}}(x,y) = \mu_{A^{i_1} \times B^{i_1}}(x,y)$$
$$= t(\mu_{A^{i_1}}(x), \mu_{B^{i_1}}(y)) \quad \forall x \in X, \quad \forall y \in Y$$
$$\text{being } i_1 = \{1, \ldots, r_1\} \tag{56}$$

with

$$\mu_{(A \cap B) \to C}(x, y, z)$$
$$s(\mu_{R^{11}}(x, y, z), \ldots, \mu_{R^{r_1 r_2}}(x, y, z)) \tag{57}$$
$$\forall x \in X, \quad \forall y \in Y \; \forall z \in Z$$

and it can be described as:

$$\mu_{(A \cap B) \to C}(x, y, z) =$$
$$s_{i_1 = \{1, \ldots, r_1\}, i_2 = \{1, \ldots, r_2\}}(\mu_{R^{i_1 i_2}}(x, y, z)) \tag{58}$$
$$\forall x \in X, \quad \forall y \in Y \; \forall z \in Z$$

and

$$R^{i_1 i_2} = (A^{i_1} \cap B^{i_2}) \to C^{i_1 i_2}:$$
$$\mu_{R^{i_1 i_2}}(x, y, z) =$$
$$t(\mu_{A^{i_1}}(x), \mu_{B^{i_2}}(y), \mu_{C^{i_1 i_2}}(z)) \tag{59}$$
$$\forall x \in X, \quad \forall y \in Y \; \forall z \in Z$$

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(BH –ed.-; BH, JMD)

G

GENERAL THEORY OF INFORMATION (GTI)
(S. *Teoría general d ela información*, F. *Théórie Générale de l'Information*, G. *Algemaine Theorie der Information*) [Trans-disciplinary, Formal theories, Mathematical theories] theory, discipline

The General Theory of Information proposed by Mark Burgin (2003, 2010) is a synthetic approach, which reveals the essence of information, organizing and encompassing all main directions in information theory. GTI has three parts or strata:

- *Philosophical/phenomenological*, which gives a new vision of information and its place in the modern world;

- *Methodological*, which studies basic principles of information theory and information technology (→*Principles of GTI*);

- *Theoretical*, which is mathematically based making available different mathematical models of information, information processes and information processing systems (→*Mathematical stratum*).

Under the awareness of the irreducible variety of information kinds, instead of pursuing a unitary definition of information, a *parametric definition* is developed on the phenomenological level of the general theory of information. By this means, information in the strict sense stands in a very flexible way for a capacity to cause changes in an infological system. It is the adaptability of these infological systems, which enables this approach to adapt to the multifaceted reality of information by means of formal models. On the other hand, on the theoretical level, the general theory of information provides tools for measuring and evaluating information.

Information levels

In the context of GTI, the concept of information is considered on three basic levels of generality:

1. *Information in a broad sense* is considered when there are no restrictions on the infological system.

2. *Information in the strict sense* is considered when the infological system consists of structural elements.

3. *Cognitive information* is considered when the infological system consists of cognitive structures, such as knowledge, beliefs, ideas, images, etc.

An infological system IF(R) of the system R is called *cognitive* if IF(R) contains (stores) elements or constituents of cognition, such as knowledge, data, ideas, fantasies, abstractions, beliefs, etc. A cognitive infological system of a system R is denoted by CIF(R) and is related to cognitive information.

Consequently, we have three levels of information understanding:

1. *Information in a broad sense* for a system R is a capability (potential) to change (transform) this system in any way.

2. *Information in the strict sense* for a system R is a capability (potential) to change (transform) structural components of this system, e.g., cognitive information changes knowledge of the system, affective information changes the state of the system,

while effective information changes system orientation.

3. *Cognitive information* for a system R is a capability (potential) to change (transform) the cognitive subsystem of this system.

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(MB)

H

HERMENEUTICS (S. *hermenéutica*, F. *herméneutique*, G. *Hermeneutik*) [Philosophy of language, semiotics, communication theory, ethical issues, information society] theory, discipline

Contents.— *1) Is difference enough or do we also need interpretation?, 2) Roots of hermeneutics (a. Between obscurity and clarity. Antiquity and Christianity, b. Modernity and the epistemology of clearness, c. From the evening of enlightenment towards postmodernity), 3) Hermeneutics in the digital era, 4) Towards a digital hermeneutics.*

1. Is difference enough or do we also need interpretation?

Concerning hermeneutics and information theory, at the very beginning of the former we found a reflection contrasting with the famous definition of the cybernetician Bateson, by whom information is "a *difference* what makes a *difference*" (Bateson 1972: 459). In contrast with this causal relation, we found in Plato's Theaetetus that "the reason [of what is said] is an *interpretation* (*hermēnéia*) of the *difference*" ("λόγος δέ γε ἦν ἡ τῆς σῆς διαφορότητος ἑρμηνεία", *Theaetetus*: 209a). What has been understood by *interpretation* has a long and varied history, but in any case, it refers to a problematic rather than a univocal process, also stressing a sense of effort. Such endeavour for a problematic sense clearly differs from the most common viewpoint regarding information, for which there is a kind of causal and blind relation between information and its results in recipients. The dominance of this viewpoint in information concerns —which can be for instance observed in the automatic benefits expected by the investment in information technologies (Pérez-Montoro 2008)— might draw us away from the awareness of the problems regarding the uncovering of sense. To this regard, Søren Brier claims that "information is not enough" in the problem solving enterprise of our contemporary societies (Brier 2008).

As mentioned above, *interpretation*, whose modern sense usually refers to the going back from the sign to its sense, has a long tradition (in the extensions of both the latin *interpretatio* or its corresponding Greek term *hermēnéia*) where we also might encounter a root for the —so to say- transparency of information.

2. Roots of hermeneutics.

a) Between obscurity and clarity. Antiquity and Christianity. In addition to the mentioned sense in Plato's work of interpretation as a problematic apprehension of sense, we also found *hermēnéia* in other Plato's works as an art of accounting for an obscure and distant meaning (*Ion.* 535a, *Statesman.* 260d). Such strain in the uncovering of the hidden is to be extensibly deepened in the medieval exegesis and its influence in the humanism trends (in both positive and negative senses).

Aristotle points out a connection, which is going to maintain a long tradition in hermeneutics: for him, *hermēnéia* is linked to language as an externalist expression of thoughts (*De an.* 420b). On the other hand, by using the term to name one of the treaties of the Organon, *Peri hermēnéias*, it is going to be later on identified as a technical term.

In Christian Middle Ages, two main trends might be identified regarding the reception of the holy truth, whose weight varied throughout this long period, and reaching both lines the consecutive times:

In early high middle ages, the Agustine's dictum "credo ut intelligam" stands for a trans-

parency and clarity of the holy message, relegating interpretation just for allegorical images of the old testament (Augustine 1888: §89).

From later high middle ages, such transparency will be doubted and moved towards the whole holy texts. In some contrast to Agustine's dictum we find Anselm of Canterbury's assert: "Fidens quaerens intellectum" (c. 1033 - 1109), remarking that the apprehension has to be active (Ortega 1956, Williams 2007).

The sense of deepening into obscure meanings to bring them to light will be stressed towards the humanism period, where these two tendencies can again be identified: on the one hand, an ecumenical strive for an interpretation of allegorical writings of neoplatonic ascendancy, as in the case of Pico della Mirandola (1463-1494); on the other hand, a relative rejection of allegoric readings in contrast with the clarity of God's word, which must be accessible to all men, as in Erasmus of Rotterdam (c.1466-1536). This last trend, alienated with the Augustinian tradition can easily be identified with the endeavour for clarity in the very core of modernity, where the question of truth is not going to be tightened to religious discourse.

b) Modernity and the epistemology of clearness. Although the prevalence of the discourse of clarity, the contrasting stances regarding the reception of sense do not diminish with the advent of modernity, on the contrary, it sometimes showed an open and sharpen conflict between the role of authority in counter-reformation and all men accessible strive for clarity in rationalism. While among the former, authority is a mediating warranty in the hardness of interpretation, in the latter, clarity is the main guidance for the spirit: "all the things which we clearly and distinctly conceive are true" (Descartes 2008, §4). This topic of clearness is going to be dominant in the rationalist and enlightenment movement, founding an epistemology in which the transparency of sense and true will be, for instance, the base of Locke's semiotic theory, which is going to play

an influential role in the scientific tradition – especially in the Anglo-Saxon world (Copleston, v.5, §7.8). In Locke we observe two tendencies that we may later encounter in the communication models of the Mathematical Theory of Communication: 1) the already mentioned *transparency* contrasting with the hardness of interpretation, 2) the regardless of context contrasting with the necessity to rebuild the –so to speak- sense scene (Díaz and Hadithi 2009). Regarding the first, Locke concludes his appraisal on general terms stating that:

> *"[...] men making abstract ideas, and settling them in their minds with names annexed to them, do thereby enable themselves to consider things, and discourse of them, as it were in bundles, for the easier and readier improvement and communication of their knowledge [...]" (Locke 1690, B.III, §3.20)*

But these *general terms* –supporting communication and knowledge- are bounded to *general ideas* which must be decontextualize:

> *"Words become general by being made the signs of general ideas: and ideas become general, by separating from them the circumstances of time and place, and any other ideas that may determine them to this or that particular existence." (ibidem, B.III, §3.6).*

c) From the evening of enlightenment towards postmodernity. After the relative unfulfillment of the Enlightenment promises, right after the French Revolution, the topic of clearness opens towards a deeper consideration of the obscure, noteworthy in the Romanticism movement as well as in the idealism. In the nineteenth century, for instance in the work of Schleiermacher, the non transparency of the text is going to be acquainted not with respect to a transcendental distance, but to linguistic, historical and cultural reasons. The restoration of the context comes to the first plane and the interpretation aims -in Schleiermacher- to "understand the author better than he understood himself" (Bollnow 1949), in the sense that even something about the historical-cultural context can be found out in the herme-

neutical process (thus beyond author's intention). The historical knowledge and interpretation becomes two faces of a same process. Such identification is going to be stressed in Dilthey for whom interpretation is an intentional understanding (verstehen) of life manifestations permanently fixed (Dilthey 1909: 319). Such interpretation process clearly differs from the "easier and readier" "communication" of "knowledge" depicted by Locke. Hermeneutics become circular: the interpretation of a reality to be understood is based on some previous (contextual) data, but the sense of this data is at the same time given by the understanding of the reality being interpreted. In other words, the outer perspectives allegedly used to 'explain' phenomena –usually by means of causal reason–, is here substituted by a inner perspective in which phenomena is recursively grasped. A similar change in the perspective of understanding is experienced in the foundations of second order →*cybernetics*.

In the XXth century, most hermeneutical theories continue the paths opened by Schleiermacher and Dilthey. If we consider the phenomenological reduction (*epojé*), through which phenomena should *clearly* manifest (Husserl 1970), as probably the last serious philosophical attempt of rebuilding the clearness project of modernity (Marías 1967: 403ss, 1980: 263-266), we might then regard the time after recognising the impossibility of the phenomenological reduction as *post-modernity*.

It is possible to establish a link between this breakdown and the discovery of Godel's incompleteness in formal systems or Heisenberg's uncertainity in physics (Díaz 2003), which might also be considered as some formal foundations of post-modernity.

As Ortega showed in his early refutation of Husserl's *epojé* (Ortega 1914) the apprehension can never be done without assumption. This is the fundament of Heidegger's hermeneutics (Heidegger 1927: §32) for whom any existence has an inherent pre-understanding of the world where it "is thrown" (geworfen); and such pre-understanding is embodied in the

language which is available to that existence. Interpretation in Heidegger becomes "the articulation of that which is understood" as well as a constitutive dimension of the existence (ibidem). This existence is "being-in-the-world with Others" and to that extend cannot be fully analysed (ibidem, §34). However the original worldly pre-understanding can be grasped in the unveiled "world", i.e. in the system of semantic relations allowing us to understand something as what can "stand out explicitly". Deepening in this line, Gadamer develops (especially focusing on art, history and language, therefore in a narrower sense that Heidegger) a fully *hermeneutical ontology* (Gadamer 1975).

But if we take a look at the Anglo-Saxon tradition we find out a practical absent of the interpretation concept as it was generalised first in the nineteenth century historicism and afterwards by Heidegger. In this tradition, interpretation has been restricted in two directions: 1st) the comprehension of discourses and literary texts, stressing devotion on literacy criticism and methodology; 2nd) *pragmatism*, where Peirce is the most relevant source. In this second line, the influence of Peirce's concept of interpretation as concerning the effects conveyed by signs (Peirce 1958: 5.475) has been of major relevance in the development of communication theory and semiotics, and also in several concepts of information.

As we posed at the beginning of this article, is there not a lack of concern in information theories with respect to the problems revealed by hermeneutic? Could not an approach between these two lines of interpretation bring new lights into information concerns?

3. Hermeneutics in the digital era. We live in societies whose political, legal, military, cultural and economic systems are based on digital communication and information networks or in societies that are making major efforts to bridge the so-called digital divide (Capurro et al. 2007). Maybe this is one reason why hermeneutics, the philosophic theory dealing

with issues of interpretation and communication, has apparently lost the academic interest it had in the nineteenth century as a relevant methodology in the humanities as well as a way of understanding human existence in the twentieth century. Santiago Zabala, editor of a recent book in honor of the Italian philosopher Gianni Vattimo, quotes Hans-Georg Gadamer, the founding father of philosophic hermeneutics, as follows:

> *Vattimo has specifically called hermeneutics a koiné: the common language in which philosophical thought after Heidegger and Wittgenstein, after Quine, Derrida and Ricoeur, has spread everywhere; virtually a universal philosophical language. (Zabala 2007, p. 3)*

Vattimo's hermeneutical critique of metaphysics and his plea for "weak thinking" can be related to Turing's halting theorem, basic to computational theory, as well as to Gödel's incompleteness theorem (Chaitin 1982) as far as these theorems state some fundamental limits to our seeking after truth, which forces us to stand back from the claims to truth of modernity as mentioned above. According to these limits, we always make theoretical and/or practical presuppositions that cannot be made completely explicit once and for all.

As shown in Capurro's paper "Interpreting the digital human" (2008) hermeneutics is intimately related since the 1970s with digital technology. After having passed through critical theory (J. Habermas), critical rationalism (K. Popper), analytic philosophy (early L. Wittgenstein, Hilary Putnam, Donald Davidson), deconstructivism (J. Derrida), the phenomenology of the symbol (P. Ricoeur), psychoanalysis (J. Lacan), dialectic materialism (A. Badiou), mediology (R. Debray), the hermeneutics of the subject (M. Foucault) and particularly through Gianni Vattimo's "weak thought" ("pensiero debole"), to mention just some of the prominent contemporary philosophic schools, Hermeneutics is facing today the challenge arising from digital technology by becoming what Capurro calls *digital hermeneutics*. Every revolutionary transformation in

philosophy that leads to the creation of a new type of rationality arises usually from an outstanding scientific or technological breakthrough (Bosteels 2006, p. 116). Today's global and interactive digital network, the Internet is one of those breakthroughs. The Internet's challenge to hermeneutics concerns primarily its social relevance for the creation, communication and interpretation of knowledge. This challenge implies a questioning of the pseudo-critical rejection of hermeneutics with regard to technology in general and to digital technology in particular (Capurro 1990). Facing the digital challenge hermeneutics must develop a "productive logic" (Heidegger 1976, p. 10) towards understanding the foundations of digital technology and its interplay with human existence. A productive logic "leaps ahead" (ibid.) of the established self-understanding of a given science, in this case of hermeneutics, in order to undertake a revision of its main concepts and disclose a new area of research.

There is a blindness in some studies of contemporary hermeneutics with regard to these challenges (Figal 2007), with a few exceptions (Irrgang 2005, 2007; Fellmann 1998; Kurthen 1992), as well as in seemingly comprehensive encyclopaedia articles (Gadamer 1974, Grondin 1996, Ramberg and Gjesdal 2005) also with a few exceptions (Introna 2005; Mallery, Hurwitz and Duffy 1990). In their article "Hermeneutics" in the Encyclopedia of Artificial Intelligence Mallery et al. do speak about the "precomputational nature of contemporary hermeneutics" and suggest "the reformulation and refinement of ideas about both hermeneutics and AI." (Mallery et al. 1990, p. 374).

4. Towards a digital hermeneutics. As argued elsewhere (Capurro 2008, 2009) the task of hermeneutics in the digital age is twofold, namely to think the digital and at the same time to be addressed by it. The first task leads to the question of the way in which the digital code has an impact on all kinds of processes, particularly the societal ones. In this regard,

digital hermeneutics is at the core of →*information ethics* understood as the ethical reflection on rules of behaviour underlying the global digital network including its interaction with other social systems as well as with natural processes. The second task refers to the challenge of the digital with regard to the self-interpretation of human beings in all their existential dimensions, particularly their bodies, their autonomy, their way of conceiving and living in time and space, their moods and understanding of the world, the building of social structures, their understanding of history, their imagination, their conception of science, and their religious beliefs.

According to Lawrence Lessig "code is law" (Lessig 1999). If this is the case then hermeneutics must reflect on the nature of this code and its interaction with economics, politics and morality. The balance between these spheres, including nature, is related to what was often called justice ("dike") in Greek classical philosophy. This concept is broader than the one applied to social interactions, particularly with regard to the distribution of economic wealth. It implies the complex interplay between humans and nature using different programs or digital codes that interact with natural processes (Eldred 2006). It would be 'unjust' if cyberspace were to dominate other spheres by becoming a digital metaphysics. The task of weakening such a project is a major task of digital hermeneutics. One example of a strong version of the digital is the dominance of mass media with their hierarchical structures in the twentieth century. Vilém Flusser feared that this power would eventually become the dominant one over dialogical structures of communication (Flusser 2006). The Internet weakens media monopolies. The digital code makes possible the interaction of the human with the natural and the artificial. The digital network weakens the classic Western view of an autonomous subject and makes possible a dialogue with Taoist views of nature (Jullien 2003) as well as with Japanese Buddhism (Capurro 2006).

Ethics deals mainly with one question: who am I? This question is not to be understood as asked by an isolated individual but as a basic human question that is stated implicitly or explicitly in practical life by every human being no less than by groups, states and today's global dimension: who are we as humankind? This question is anything but academic. It is a question of survival. Hermeneutics in the digital age must become aware of this situation in order to make explicit the different political, legal and cultural norms and identities, the way they are affected by the digital code and the consequences for the construction of human identities as well as for the interaction between nature and society. Following Foucault, ethics can be understood as the questioning of morality (Foucault 1983). It works as a catalyst of social processes weakening the dogmatism of morality and law without just striving towards their replacement through another moral code. It is an open or free space that allows for a permanent critique of all kinds of blocking processes within and beyond the digital sphere. Who are we as a society at the local and global level in the age of digital and globalized communication? This question does not address a problem of text interpretation but our own self-understanding and 'verification' in the sense that the media itself and the processes that are object of hermeneutical study are at the same time existential dimensions of the interpreters themselves The hermeneutic subject 'verifies' or makes herself a digital object.

Human existence is a valuing activity but the human evaluator has no value but a "dignity" or "Würde" as Kant called it. This is not necessarily based on a metaphysical view of man and world but arises already from the very situation of being-in-the-world itself as far as this being itself is not something we could valuate but is the horizon within which every valuation takes place. Within this horizon, all beings, human or not, have a dignity but non-human beings, as far as they are not subjects of valuation processes, have a relative value

when they become object of human transactions within a social process of valuation. From this perspective, the economy as a process of permanent valuation is a main trait of every human community as such. This hermeneutic reflection makes clear why the digital sphere as a product of human invention, cannot become the final horizon of valuation for all possible understanding of the world and human existence. Being relative, the digital becomes an opportunity for the subjects of the twenty-first century to transform themselves and their connections in and within the world overcoming for instance the strong metaphysical concepts that were leading for the self-understanding of Western societies for centuries. This does not mean that such concepts could be set aside or just replaced by the new ones, but they can be hybridized with different kind of reasons, imaginations, ambitions and utopias, hopes and disappointments arising from the digital code.

If this is the case, in different ways and intensities, the digital code becomes a real contribution to humanity as well as to its interaction with non-human spheres. It could weaken the metaphysical ambitions of (Western) logos by making it more flexible with regard to the global cultural interplay in which we look for reasons for our preferences in dialogue with different beliefs and desires of other human beings. A future world must be open to an open horizon of understanding in which the "principle of charity" plays a major role avoiding the danger of reasons becoming dogmatic beliefs to be eventually imposed on others by force. The digital network could become the place where such translations between different languages take place in a global scale in this new century. This means allowing the other to articulate herself in the network, looking for nodes of relations, becoming as a hermeneutic subject of the digital age. This is the reason for the relevance of intercultural information ethics (Hongladarom and Ess 2007; Capurro et al. 2007).

Who are we in the digital age? What does it mean for humanity to become transformed through the digital code? What are the epistemological, ontological and ethical consequences? How do human cultures become hybridized and in which way does this hybridization affect the interplay with natural processes and their interplay with the production and use of all kind of artificial products in a digital economy? These questions go far beyond the horizon of classic hermeneutics as a theory of text interpretation as well as beyond classic philosophic hermeneutics dealing with the question about human existence independently of the pervading impact of digital technology. We live in a world that is less and less a familiar "life-world." We have become a troublesome field that requires hard labor and heavy sweat ("factus sum mihi terra difficultatis et sudoris nimii"; Augustinus 1998, X, p. 16). Hermeneutics misunderstands itself if it does not take care ontically and ontologically of digital technology with its overwhelming impact on our lives. Whereas digital technology would pursue an empty target, if we believe that "information is enough" and we neglect restoring "the reasons of what is said". Thus we might be building up a "meaningless" Information Society.

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(RC –ed.-; JMD, RC)

HOLOGRAPHIC PRINCIPLE (S. *principio holográfico*, F. *principe holographique*, G. *Holografisches Prinzip*) [theoretical physics] concept, theory

This principle, suggested by Gerard't Hooft in 1993 and developed by Leonard Susskind (1997), points out that the information contained in a volume can be represented by information over its bounding surface.

Since there is a (quantum) limit in the entropy by surface unit (for every four Planck areas there is at most one degree of freedom –or a entropy unit corresponding to a Boltzman constant): the maximum entropy contained in a volume bounded by a surface of area A (measured in Plank areas) is A/4, which is named holographic bound.

The holographic principle is related to the "generalized second law" [of thermondynamics], proposed by Bekenstein, stating that "the sum of black hole entropies and the ordinary entropy outside the black holes cannot decrease" (Bekenstein 2003).

By extension of the holographic principle, Bekenstein suggests that if the physics of our real universe (four-dimensional) were holographic, there would be an arbitrary set of physical laws to be applied on some three-dimensional bound of the space-time (i.e. the horizon of events).

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(JMD)

I

IMAGE (S. *imagen*, F. *image*, G. *bild*) [audiovisual, aesthetics, communication theory, cognition, message] _{concept}

"Image is always shaped by deep structures attached to the exercise of a language, as well as to the membership in a symbolic organization (a culture, a society); but image is also a means of communication and representation of the world that has its place in all human societies". (Jacques Aumont)

Hans Belting says that an image is more than a product of perception. It manifests itself as a result of personal or collective symbolization. We know many of the events of the past, present and future through images that provide us, altogether, with a view, that is, with an idea, a concept, a sense of the period or situation.

Thus, there are images that we see, but also mental or conceptual images that can act as benchmarks, models or diagrams helping us to interpret the world and our relationship with it. Currently, more than ever, we receive the information we process, analyze and synthesize at different levels, through visual images that act on the receptor differently depending on the context and circumstances where they manifest themselves.

Logically, in turn, our mental images nourish themselves from the visual content circulating through the Technologies of Information and Communication; this provides a new paradigm for the decoding of messages, the interpretation of content and the development of communication mediated relations, in which images are the absolute protagonist, displaying their variegated meanings and presented

through different media and in diverse formats.

But, *what is a visual image?*

Visual image are the ones we perceive through sight, displayed in a support, material or medium. A visual image is a photograph, a sculpture, painting, illustration, engraving or the interface of the computer screen. Images never present themselves, but always re-present, because they are displayed in a new material or medial dimension. This means that the referent acquires a concrete, new, synthetic or emphatic meaning when it is displayed through an image, which completes its full sense when it is interpreted by a receiver.

As *Vilches* argues, images are empty forms, and require, if they have to transmit information, an observer's interpretative competence to complete them with contents. An image is a proposition of which the receiver extracts the contents and meaning producing the phenomenon of communication in time and space. The material and the immaterial are unified in the image, which always needs a context and a specific time to be interpreted accurately.

Moreover, rather than the presence of an absence, the image is defined as a synthesis, as an emphasis on an intention to mean something. We say "a" synthesis and not "the" synthesis, because the same image, depending on the context, the intention of the issuer, or the perception of the receiver, can offer many senses. Therefore, the sense an image can have is not hermetic, but it depends on the interaction of several factors. *Régis Debray*, in *Vie et mort de l'image*, says that we internalize the images-

things and externalize mental images, so that imagery and imagination induce each other.

The classification of images has been, and is, a path chosen by different authors to come near a definition of the concept of image. We can dwell on the arguments of some of them.

Abraham Moles establishes four features of images: the degree of figuration (the representation of objects or known beings), the degree of iconicity (the abstraction concerning the item represented), the degree of complexity (the various plastic elements) and the degree of normalcy (which is related to diffusion or copying). For Moles, visual messages allow us to represente a fragment of the world, whether real or imaginary; the visual communication process is established with an exchange of signals between the sender and receiver, either in a purely conventional framework or exploring an imaginary world in which different levels of abstraction are established or schematized. These different levels are what he calls the scale of iconicity.

Martine Joly points out that there are three factors that play a role in the transmission of information through images: plastic signs (colors, shapes, textures and space), iconic signs (pictures and motives) and linguistic signs. Joly starts out from the idea of analogy, and explains that an image is something that resembles something else. Thus, in the study of the photographic image, she establishes two distinct levels: "observation" and "interpretation", and believes that in reading an image an interaction between it and the reader is established which causes a series of expectations such as memorization and anticipation.

For *Donis A. Dondis* there are three levels of visual expression: representation, which means particularity, abstraction, which means universality, and symbolism, which is conventional. It must be said that these three levels of information are interconnected. Besides proposing this general classification, she states that the content and form of an image are inseparable; in visual communication this di-

chotomy does not occur. Any message is composed with a purpose (i.e., to express, explain, direct, incite, accept) which, to be significant, requires the optimization of the formal expressions.

On the other hand, *Rudolf Arnheim* distinguishes three functions, not classes, coining the terms of representation, symbol and sign. However, the most interesting part of his theoretical contribution is his formulation of "visual thinking". Arnheim says that visual perception is visual thinking, taking the first to be not a passive record of observed material, but an active interest of the mind. Also, images stored in memory are used to identify, interpret and contribute to the perception of new images. Arnheim's point can be used to connect the two sorts of images we mentioned earlier in this article: visual images and mental images.

Jacques Aumont also distinguishes three modes, namely: the symbolic mode, as when the divine presence materialized through idols venerated as sensitive manifestations (although it must be said that images, in its symbolic form, have also been used in the secularization of Western societies to transmit new values); the epistemic mode, as when images provide information and knowledge about the world; and the aesthetic mode, in which images please the viewer and provide him specific sensations.

Visual studies, which have visual culture as object of interest, analyze the information contained in images, focusing on how technology, media and social practices of representation and reception are deeply interwoven with human societies, ethics and politics, aesthetics and epistemologies of seeing and being seen.

W.J.T. Mitchell thinks that images have "lives" generated by those who created them; he focuses not only on the field of art, but also argues that visual culture is nourished by the most varied expressions from all areas. Moving beyond a semiotic view, he maintains that images are presented to us, and that we can not describe or interpret them linguistically.

Although they are related, words and images belong in knowledge categories that can not be compared with each other.

The multiple visual environments of our time lead us to process information in a non-linear, immediate and fleeting way. In images we see, reflected, the environments where we operate, but also through images what exists, which can be intangible or, paradoxically, not visual, manifests itself. The fact of "putting in images" emotions, desires, arguments or different intentions helps us discover new ways of imagining reality.

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(LS –ed.-; SBB)

INCREMENTAL INFORMATION (S. *información incremental,* F. *informations supplémentaires,* G. *inkrementelle Information*) [Situation theory] concept

Incremental informational content: relative to constraint C', and given event s', a situation s carries the information that there is a situation of type S" if and only if:

a) There is a constraint C' holding between the type that results from the conjunction of S and S', and the type S" (C = [S S' => S"]).

b) The anchoring event s' is of type S'.

c) The situation s is of type S.

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(LS –ed.-; CA)

INCOMPLETENESS (S. *incompletud, incompletitud,* F. *incompletude,* G. *Unvollständigkeit*) [transdiciplinary, logics, recursiveness theory, formal semantics] concept

Gathering things is quite different from gathering sentences. Things, in its most general sense (what the classics called transcendental) are gathered in sets or bigger classes, up to the proper class of everything. We may say such a huge collection is complete. But notice it is deprived of the collection of all and only incomplete collections. Hence it is not complete after all.

More modestly, we may gather all things that are sentences of a language. Just as in Borges' Babel Library, where the infinite set of all possible sentences are compiled. This set may seem somehow complete, but again notice it is not particularly interesting, since it is a trivial chaos where anything expressible is expressed.

So let's now gather, even more modestly, only all the true sentences of a language. This is the first useful sense of completeness. Given a domain of interpretation and a language referring to it, a set of sentences is model-complete if it contains all sentences that are true in such a domain. Notice that other languages with different expressive power may also contain this set among their sentences; just as such a domain may be described by other languages. A mathematically precise notion of "domain of interpretation" brings us to distinct semantics. It's certainly not easy to gather model complete set of sentences. Accumulating all truths about my left little finger is a huge task. Even gathering all expressible truths about my left little finger is an impressive unprobable piece of work. However, there are a number of such

huge tasks that we perform with our tiny brain, poor resources and limited time.

Learning a natural language is one of them, since it involves the task of acquiring a recursive procedure to access the infinite set of all sentences. Another example of the application of finite rules to construct an infinite amount of finite sequences is Babel's Library as described by Borges, which is learnable or constructible with just the alphabet.

Another computable procedure with the same recursive structure is the one constructing deductions or proofs from rules and axioms. In this case sequences of sequences are recursively formed, in such a way that an infinite set of truths can be condensed in a finite, even small, set of axioms.

Is there a similar procedure to recursively obtain a model-complete set of truths?, that is, a recursive or computational means to access all truths with respect to a certain domain of interpretation?

Take for example the natural numbers, as the infinite domain standardly interpreting arithmetic. Let the language of arithmetic be given, say as was informally taught to us in school. Moreover, we have a computational procedure to calculate logical consequences from basic axioms of arithmetic (as discovered by Peano and Frege). Do we have then a logical procedure to compute all arithmetical truths? Gödel proofed that such a procedure does not consistently exist, the proof being the first incompleteness theorem. This answers negatively the question whether a model complete collection of truths is accessible by purely recursive or computational means. Notice it does not answer the question of whether non-recursive methods are available to access the set of all truths (arithmetical or of another nature).

Annexed files include several explicit proofs and additional materials. for the notion of inform.

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(FS)

INDEXING LANGUAGE (S. *lenguaje documental*, F. *langages documentaires*, G. *kontrolliertes Vokabular*) [Information management, documentation, Library and Information Science] concept

Indexing languages are a subset of natural languages used to describe documents. These languages are part of the information science techniques used to describe resources. The goal is to represent information in order to improve the retrieval of relevant documents.

There are several types of indexing languages. The oldest are library classifications and subject headings. In recent times, Computer Science's development and changes in information needs has brought new indexing languages.

Indexing languages are concerned by two factors:

— Considerations regarding linguistic aspects
— Functional considerations. In specific contexts these tools are used to improve performance.

1. Types of Indexing languages

d) *Free Language*: (i) Uniterm lists, (ii) Keyword lists, (iii) Glossaries, (iv) →*Volksonomies*

e) *Language codes*: library classification schemes

f) *Controlled vocabularies*: (i) Based on hierarchies: →*Taxonomies*, (ii) Based on hierarchies, associations and equivalent terms: Thesauri and subject headings, (iii) Based on terminology ontologies in a specific context and with associations to current resources: →*Topic Maps*.

2. Thesaurus as a reference model.

Thesurus is a prototypical indexing language. A thesaurus is structured as a semantic network limited to a domain. This network is composed of nodes, and each node represents a concept. This is an agreed language, with shared definitions in the domain. It is controlled in the sense that only the thesuarus' terms could be used to describe a resource. This principle guarantees uniqueness in the relationship concept-term. As a tool to control terminology it has the following term types:

— Descriptors (terms used to represent the concepts within the domain).
— Non-descriptors (terms from the domain that have an equivalent in the list of descriptors. These terms are not used to represent documents, using the equivalent descriptor).

Descriptors are related by means of:

— Hierarchical and associative relationships
— Equivalence relationship to relate Descriptors and Non-descriptors.

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(JAM)

INFO-COMPUTATIONALISM (S. *Info-computacionalismo*, F. *Info-calcul*, G. *Info-Berechnung*) [Transdiciplinary, Philosophy of information and computation, Computation theory] theory

Info-computationalism is the view that the physical universe can be best understood as computational processes operating on informational structure. Classical matter/energy in this model is replaced by information, while the dynamics are identified as computational processes. In this view the universe is a gigantic computer that continuously computes its next states by following physical laws. Info-computationalism thus appears as a conjunction of two theses: one about processes (computation) – pancomputationalism (see e.g. Chaitin, 2009) and one about structure (information) – paninformationalism (see Floridi, 2008).

What makes info-computationalist naturalism a promising research programme is, according to (Dodig-Crnkovic and Müller, 2010):

— Unlike mechanicist paradigm, info-computationalist naturalism has the ability to tackle as well fundamental physical structures as life phenomena within the same conceptual framework. The observer is an integral part of the info-computational universe. (See Dodig-Crnkovic, 2010)
— Integration of scientific understanding of the structures and processes of life with the rest of natural world will help to achieve "the unreasonable effectiveness of mathematics" (or computing in general) even for complex phenomena of biology that today lack mathematical effectiveness (Gelfand) – in sharp contrast to physics (Wigner).
— Info-computationalism (which presupposes pancomputationalism and paninformationalism) presents a unifying framework for common knowledge production in many up to know unrelated research fields. Present day narrow specialization into various isolated research fields has led to the alarming impoverishment of the common world view.

— Our existing computing devices are a subset of a set of possible physical computing machines, and Turing Machine model is a subset of envisaged more general natural computational models. Advancement of our computing methods beyond the Turing-Church paradigm will result in computing capable of handling complex phenomena such as living organisms and processes of life, social dynamics, communication and control of large interacting networks as addressed in organic computing and other kinds of unconventional computing.

— Understanding of the semantics of information as a part of the data-information-knowledge-wisdom sequence, in which more and more complex relational structures are created by computational processing of information. An evolutionary naturalist view of semantics of information in living organisms is given based on interaction/information exchange of an organism with its environment.

— Discrete and analogue are both needed in physics and so in physical computing which can help us to deeper understanding of their relationship.

— Relating phenomena of information and computation understood in interactive paradigm will enable investigations into logical pluralism of information produced as a result of interactive computation. Of special interest are open systems in communication with the environment and related logical pluralism including paraconsistent logic.

— Of all manifestations of life, mind seems to be information-theoretically and philosophically the most interesting one. Info-computationalist naturalism (pancomputationalism + paninformationalism) has a potential to support, by means of models and simulations, our effort in learning about mind and developing artifactual (artificial) intelligence in the direction of organic computing.

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(GD)

INFORMATIVMORPHISM (E. *Infomorfismo*, F. *Infomosphisme*, G. *Infomorphismus*) [transdisciplinary, logics, semantics, situation theory] concept

The mathematical concept of morphism tries to produce an image of a set that captures its structure. The notion of infomorphism generalizes and extends this idea by means of defining certain homomorphism among structures supporting infons. The concept emerged originally in situation semantics and it has been applied in distinct contexts.

INFOMORPHISM (E. *Infomorfismo*, F. *Infomosphisme*, G. *Infomorphismus*) [transdisciplinary, logics, semantics, situation theory] concept

The mathematical concept of morphism tries to produce an image of a set that captures its structure. The notion of infomorphism generalizes and extends this idea by means of defining certain homomorphism among structures supporting infons. The concept emerged originally in situation semantics and it has been applied in distinct contexts.

Any set A includes all elements or tokens defining a family R of relations on A. Let us call relational structure **A** the set A with these relations. Let **A**, **B** respectively be relational

structures <A,R> y <B,S>. Taken with benevolence, an homomorphism from **A** to **B** is defined as any function f from **A** into **B** such that: If R(a1...an), then S(*f*(a1)...*f*(an)). **B** is then a homomorphic image of **A**.

Consider now the specific relational structure which we may call classificatory relational structure **A**, taken as the result of classifying the elements or tokens of A by means of a set Σ_A of types. For example, the set of tokens: {a, a, a} corresponds to a unique type a. We write

$$y \mathrel{\rule[-0.3ex]{0.05em}{1.6ex}\!\!\raisebox{-0.3ex}{\rule{0.6em}{0.05em}}}_A x$$

to say that the token x instantiates the type y. Barwise and Seligman (1997) called classifications such classificatory structures

$$A = <A, \Sigma_A, \mathrel{\rule[-0.3ex]{0.05em}{1.6ex}\!\!\raisebox{-0.3ex}{\rule{0.6em}{0.05em}}}_A>$$

where A is the grounding token set, Σ_A the set of individual types and $\mathrel{\rule[-0.3ex]{0.05em}{1.6ex}\!\!\raisebox{-0.3ex}{\rule{0.6em}{0.05em}}}_A$ the relation of being an instance of.

Let **A** and **B** both be classificatory structures:

An infomorphism i relating **A** y **B** consists in *a pair of functions f⁺ (from Σ_A to Σ_B) and f (from B to A) such that, for every type α of **A** and every token β de **B**: f⁺(b)*$\mathrel{\rule[-0.3ex]{0.05em}{1.6ex}\!\!\raisebox{-0.3ex}{\rule{0.6em}{0.05em}}}_A$* α $\Leftrightarrow$ b $\mathrel{\rule[-0.3ex]{0.05em}{1.6ex}\!\!\raisebox{-0.3ex}{\rule{0.6em}{0.05em}}}_B$ f⁻(α).*

Schematically:

$$\spadesuit_A \quad \Delta \quad \spadesuit_B$$
$$\Phi \qquad \Phi$$
$$A \quad X \quad B$$

As an homomorphism preserves structure, so an infomorphism preserves the instantiation relation, among sets that can be quite distinct, but informationally analogous.

In the references (Devlin, Gunji) you may find relevant examples of infomorphisms.

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(FS)

INFON (S. *Infón,* F. *Infon,* G. *Infon*) [transdisciplinar, lógica, semántica] concepto

You being happy is a state of things composed by the object you instantiating the relation being happy. State of things such as: <<happy, you, yes>> are to be distinguished from other realities, such as the object you happy and the property of happiness-in-you. An ontology composed by things as you is distinct from another one composed by state of things.

Notice how properties and relations are instantiated in objects (your happiness, the red of my lips), while objects are not instatiated in other objects: they are fragments or parts, but not instances. Even if there is, through-out the milennia, no precise characterization of these basic notions of part and instance, both set theory and situation theory begin with some basic assumptions about both no-tions.

Now, situation semantics assumes that situations are parts of reality which also have parts being states of affairs whcih are information. They are, it is assumed, objects instantiating properties and relations. Infons are the mi-nimal information units posed by the onto-logical and set theoretical tools of situation semantics. Notice that information is not only refered to a situation, but it is such situa-tion.

Therefore, infons are states of things ex-pressible as tuples in the form

$$<<R, a_1, a_2, ..., a_n, 1>>, <<R, a_1, a_2, ..., a_n, 0>>$$

where R is a relation between n appropiate objects denoting that such objects are or are not in the relation. The final element is called polarity and signals the veracity $<<R, a_1, a_2, ..., a_n, 1>>$, or the falsity $<<R, a_1, a_2, ..., a, 0>>$ of the relation R.

Given a situation s and an infon σ, we write

$$s \lfloor \sigma$$

if the infon σ is supported or made factual in the situation s. In other words, the situation s is a fragment of reality which supports or carries the information σ, eventually among many other states of things that happen to be real in that situation.

Given the notion of infon, we can define the class of situations supporting such an infon. For example, <<war making, Afghanistan, western countries, yes>> is supported in distinct situations through history, as in s_1, the 19th century british war making, s_2 the 20th century russian war making, s_3 the 21st century US war making. Different situations instantiate types of situations: given a relation R, let **s** be an assignment of real entities instantiating R. A type of situation is a pair <<R, **s**>>, that can be satisfied or supported in different situations. We write:

$$s \lfloor <<R, \mathbf{s}>>$$

to indicate that the situation s supports or satisfies the type <<R, **s**>>.

Note that a situation not satisfying a given type does not imply it satisfying that type's negation.

The concept of type of situation makes it possible to introduce propositions in an in-fon setting; at least some particular family of propositions. A simple proposition is formed by a situation s and a type of situation <<R,**s**>> so that: *proposition* (s, <<R,**s**>>) *is true if and only if* $s \lfloor$ <<R,**s**>>

Finally, an infon is a fact just in case the actual situation supports it.

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(FS —ed.-; CA, FS)

INFORMATION AESTHETICS (S. *en*, F. *fr*, G. *al*) [transdisciplinary, ICT] concept, theory, theorem, discipline, author, resource

"Reality is a formality being present to man, not by a concept, or by a reasoning, but -from my viewpoint- by an act of what I have called Sentient Intelligence, namely by an impression." (X. Zubiri)

We consider aesthetics as the way in which subjects are aware of their identity. In an active way, they try to reach the reality they belong to and with which they have an interdependence relationship, this means that subjects are a way in which reality crystallizes. This way is depending on a space and temporary framework that expresses it in terms of action and relation. It appears as a necessity for all the formalizing synthesis and it will serve as a tool to approach to the information from everywhere wanting to make it of one's own. This implies a real perspectiviness, a relation between analyzing and analyzed that puts the known subject in a period between relationships, in an aesthetic space.

Inside the concept **Aesthetics of Information** we can introduce a lot of methods and authors belonging to different fields of knowledge. Some of them are the following:

In the middle of the XIXth century **M. Weber** established the known fraction that tried to emphasize a quantitative measure applied to the process of perception. For that, he used the concept of intensity in the stimulus, something that till that moment was a bit ambiguous. So that, to perceive a change in a stimulus it is necessary that it grows in a constant proportion in relation to its true magnitude:

$$\Delta E/E = K$$

This notion acquires a logarithmic form in the work of **G. Fechner** makes it more difficult adding to the term the one of intensity of the sensation. While this grows in an arithmetic progression the one of the stimulus grows in a geometric progression. The intensity of the stimulus S depends on the logarithm E in relation to two constants K and C, where

$$S = K \cdot ln\, E + C$$

S. S. Stevens, thinking about Weber's law the same as Fechner, ended improving the formula. In his case the variation of a sensation is not constant in relation to the sensation but it is proportional to it. The intensity of the sensation S is equals to the constant C multiplied by the intensity of the stimulus E:

$$S = C \cdot E^k$$

But in all cases if the stimulus is any element or agent that stimulates, provoking a reaction in the body, whereas sensation in the impression produced, then it is expected that any quantitative formula intending to measure sensation will reduce its applicability hindering any comparison between stimulus (the applicability depends on the determination of the field, which nowaday runs the risk to be restricted to the fields of media and ICTs).

A bit later, **W. Wundt**, follower of the ideas of Helmholtz, gave the first steps through the door that the previous physiological method has opened. He not only gave psychology a method but also he gave it the scientific character that it has currently. On the one hand he analyzes the sensations with comparative systems that play with a reality that is supposed to be objective, and on the other one he analyzes the subjective sensation that provokes in people. His new structuralist idea would generate a long list of followers.

While this was happening in Leipzig, in Weimar the **chool of psychology of the Gestalt** was being founded: M. Wertheimer, W. Köhler, K. Koffka and K. Lewin will say to the world that perceptions are not a group of isolated images but they consist of configurations that function as structured unities. **Max Wertheimer**, creator of the school, shows a whole series of innate laws that organize perception. **Koffka** analyzes the way in which the human being and the environment interplay to develop a theory of the human behaviour. **K. Lewin** starts from the idea of gestalt, which first differentiates the figure from the background. He develops his theory according to

the idea of environment that functions as the framework in which the human being develops. For that he takes from Physics the concept of field, understood as the place where the particles interplay. For him the behaviour is a functionbetween the person and the environment: $C = f(p.a)$. This communion shows that it is impossible the conception of the human knowledge without taking into account the field, and also that it cannot be thought a figure without a background. **Köhler**, in his investigations about the primate reasoning, concludes that learning is not the result of a method of experiment and error, as the behaviourist thesis said. On the contrary it showed spontaneously and suddenly.

Karl Bühler, who had also been formed in the Weimar school, develops a complete theory about language. He analyzes the sign from the point of view of the speaker, of the listener and the referent and he established three respective functions of language: the representation, expression, and appeal. His pupil **Karl Popper** adds a new one: the argumentative. As they established relations on the way the brain orders thought, the development of the structuralism was near.

The analysis of the configurations through which the human being discovers reality is scientific, but we cannot forget that to do it we need to leave the logic of the speech. That is to say, formal analysis needs to be articulated by rules that are beyond it for both, Science and Language, need rules to be articulated and because of it they have a determinist character. The basis of the problem is in the final profile of some tools that are really hermetic, in the case of the formal definitions in general as well as in their symbolic side. **R. Jakobson**, using again the mathematic theories of information of Shannon and Weaver and influenced by Bühler's ideas, develops a linear model of communication where he describes six functions of language (referential, emotive, conative, phatic, metalingual, and poetic) related to the six basic elements of the communicative process (context, sender, receiver, message, common code and contact)

It is from scientific and mathematical theories and languages that **E. Cassirer** takes the concept of function to develop a philosophy of symbolic forms. The human capability of being able to name, turns reality into a symbolic concept and becomes part of it. That data originates complex symbolic forms integrated in all areas and functions of the human being. This integration creates perceptions which separate from prior data. Critical thinking does not come with reason but with its cultural aspect. It is a criticism to knowledge which is created as a historic criticism that enriches previous meanings constantly.

G. Birkhoff approaches to aesthetics through mathematical studies on music and geometric. In the thirties, he published his book Aesthetic Measure that shows the quotient between the order and the complexity:

$$M=O/C$$

Both notions come from a rereading of the idea of symmetry, of repetition, of regularity. If order refers to the regularity of elements of an image, the complexity refers to the number of elements that form that image. His work begins the interest for the quantitative and mathematic formalization of the aesthetic aspects generating a way that will be followed by authors such as A. Moles, M. Bense o R. Arnheim, among others.

Regarding **A. Moles**, he mixes technical, physical and philosophical knowledge with some aspects of structuralism with the human behaviour in the communicative process to develop his sociological and statistical studies. In his book *The physical structure of the musical and phonetic signal*, of the year 1952, he analyzed how a signal becomes lower till it isn't perceived. Six years later he published Theory of the information and aesthetic perception where his deductions began in the road of measurability designed by Weber and in the theory of behaviour of Pavlov. In his work it is shown up the interaction between the semantic and static aspects of the message. He works on concepts such as the greatest information, the originality, the complexity and the

redundancy. His gestalt approach of the form develops a sense of unity that follows parameters contrary to chance. His structuralist method analyzes the communicative action within a context in which he places a sender and a receiver that share the same language and, for that, the same index and a common code, emphasizing original, understandable and foreseeable elements.

For **M. Bense** the aesthetic aspect of the communicative process belongs to its own physical support. In his Aesthetic of information he criticizes the arbitrariness and limits that the application of Birkhoff's formula shows, emphasizing the order version of S. Maser. In the new formula the amount of complexity aspects will be taken into account. His work is completed by a theory about text, chosen as an example of order and display of aesthetic elements.
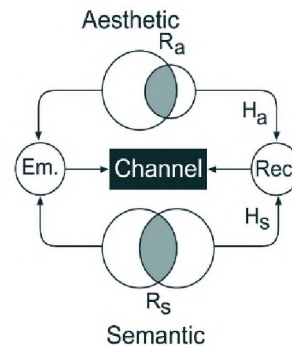

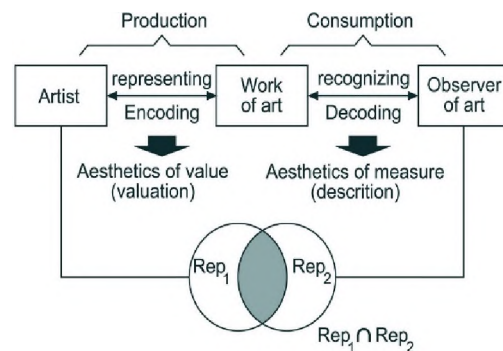Figure 1: Communicative system taken of A. Moles; B. Vallancien (1963)

Figure 2: Communicative system in M. Bense (1972).

The anthropological turning is due to **H.-G. Gadamer** based on Dilthey, Husserl or Heidegger´s phenomenology. From his hermeneutic perspective, he criticizes the limits of the scientific method when being applied to the study of interactions within the communicative process. Understanding stops being an aspect of behavior to become the individual behavior of a person who is trying to interpret his reality. He looks into the sifnificant structures on knowledge, analyses the person´s existence and leaves behind the exact method, inflexible and out of its context.

In the 60s the **Frankfurt School** is formed. A group of left-wing thinkers from different disciplines, Th. W. Adorno, J. Habermas, M. Horkheimer and F. Oppenheimer, who undertake some social studies which criticize the political tradition of the time, although with no common criteria. **Th. W. Adorno,** who belongs to the dialectical method, studies the limits of critical thinking, taking into account the media pressure that the person has to undergo in an industrialized society, which is culturally deshumanized and which creates a genuine pressure that deprives ideologies. Following Horkheimer, he forms a social criticism in which he confronts the ideal being with the real one. Reason can´t be historic, there´s always a criticism.

J. Habermas goes further. He creates the Theory of Communicative Action confronting two rationalities: on the one hand, the substantive according to the internal perspective of the human being and, on the other, the institutionalized system according to an external perspective, which is shown through its structures and complex formal processes. In this framework the rules of the communicative action show behaviours which must be analysed from the different positions of the subjectivist methods.

The Constance School, with Jauss and other researchers, will study the texts focusing on the analysis of form and content. It is not a matter of reaching a unique truth; the communicative process constantly enriches reality.

H.-R. Jauss, influenced by structuralism, shows how meanings separate from the person through history. That is why he explains the need of an interpretive hermeneutic method which provides the text with sense away from a historic vision.

The second half of the XXth century brings out some different points of view about the aesthetic information. In psychology, **R. Arnheim** says that the human being approaches to reality through his senses thanks to forms of perception. In fact, perception and knowledge are deeply united. The very sensitivity is the one that develops intelligence.

In the semiotic method data do not have importance or order till they do not have meaning. **Ch. Morris** studies the role of the receiver as the one who interprets the signs of language. If the aesthetic measure of Birkhoff seemed a bit simple, the value of the iconic sign of Morris is quite complicated. His qualitative analysis is left for the aspects of the speech. As the study begins to take into account the figure of the person who interprets, his behaviour starts to be more important and impairs the semantic aspect of the study. **U. Eco** develops and generalizes the semiotic analyzes as communicative facts related to all society.

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(JGS –ed-; JGS, JMD)

INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) (S. *Tecnologías de la Información y las Comunicaciones –TICs*, F. *Technologies de l'Information et de Communication* -, G. *Information- und Kommunikationstechnologien*) [Transdisciplinar, Information Society] concept, discipline, resource

Currently, our society is characterized by a growing and determinant emphasis on information and knowledge in wealth production. This constitutes the so-called information age, information society or knowledge-based society. This information age is characterized by the use, distribution, storage and creation of new information and knowledge resources through the application of information and communication technology (ICT). ICT is a set of advanced techniques, developments and devices that integrate functionalities to information storage, processing and transmission. This term is used to refer to informatics connected to the Internet and especially the social aspect. These technologies can be used for educational purposes and cultural global promotion as well.

Technologies dealing with the treatment of information offer a special service to society since they make possible activities like researching, organizing, and handling data, information and knowledge along with other electronic media like the cell phone, fax, Internet and television. This media have produced a significantcultural change as long as -in principle- people have access to real knowledge, assets and intangible cultural values. ICT is not egalitarian. It is prevalent in wealthy countries, especially among upscale social groups as a mechanism to replicate inequality. However, there is a difference with regards to traditional inequalities: ICT penetrates faster and stronger among young people. What we know as the →*digital divide* does express these inequalities. This information society exclusion is no other than a new way to segregate people. This can be called digital marginalization. This marginalization is the result of the technology revolution. Evidently, this is not resolved by connecting computers in a network since core problems may remain the same. These problems are amplified by the access to different avenues to grow faster excluding even more developing countries. This asks for resolving essential rights to favour integral individual self-improvement allowing the participation in current changes in nourishment, education, health, and work rights.

Knowledge production, diffusion and use should be transformed into the main growth opportunity as farming or industrial productions once were. Otherwise, we will have no other chance to participate in the knowledge society and we will only become mere spectators. This issue is not really new. We have

found out that the development is the result of the knowledge that countries are able to generate, diffuse and manage. Nowadays, this is so evident that differences are still raised exponentially.

Our times are the current stage of transformations and radical changes so relevant that some people do not hesitate to claim we are living a third industrial revolution. This is no other than the so-called technology and communication information revolution. It goes along with a change in the knowledge system. For several decades now, the extent of technology transformation has been influencing the means for the creation, treatment and diffusion of knowledge. We believe this may bring about a new digital knowledge age.

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(EM)

INFORMATION ARCHITECTURE (S. *arquitectura de la información*, F. *Architecture de l'information*, G. *Informations-Architektur*) [Research and practice] concept

Information Architecture is born in the late 1990s, based on the classical principles of solid traditional Information Science (mainly from the discipline of the Organization and Representation of Knowledge). In a technical sense, it is a discipline (and at the same time a community of practice) focused on design principles and architecture of digital spaces in such a way that they comply with criteria of usability and information retrieval. In other words, it is a discipline that deals with structuring, organizing and tagging elements of informational environments to facilitate searching and retrieval of the contained information, thus improving the usefulness of information environments by users.

One of the main characteristics of the information architecture in an information environment (for instance, a web page) is that it is usually not recognizable by the users. In other words, such architecture is invisible to the user, though there are in fact a number of (not visible) articulated systems or structures, defining the information architecture of, for example, a web page. These systems or structures are called *components* of the Information Architecture of a web or also *anatomy* of the Information Architecture of a web. Among these systems or structures that build the information architecture there are systems such as: organization systems, labeling systems, navigation systems, search systems and controlled vocabularies.

Organization systems are classifications that allow structuring and organizing the contents of a website. The *labeling systems*, however, define the terms used to name the categories, options and links used on the web with a useful language for users. *Navigation systems* permit to navigate or move through a site to find the information we need; showing us where we are and where we can go inside the structure of a site. *Search systems* enable the retrieval of information within the website using tools such as indexes. Finally, in this context, *controlled vocabularies* are documental resources designed to articulate other systems and to facilitate information searches and retrievals.

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(MPM. –ed.-; MPM., MG)

INFORMATION ETHICS (S. *ética de la información*, F. *étique de l'information*, G. *Informationethik*) [information society] discipline

Contents.— *1) Introduction, 2) The Global Impact of ICT on Society and the Environment, 3) Digital Media Ethics: an intercultural concern, 4) Towards a common world: new risks, new responsability*

Digital ethics or *information ethics* in a *broader sense* deals with the impact of digital Information and Communication Technologies (ICT) on our societies and the environment at large. In a *narrower sense* information ethics (or digital media ethics) addresses ethical questions dealing with the internet and internet-worked information and communication media such as mobile phones and navigation services. As we will argue, issues such as privacy, information overload, internet addiction, digital divide, surveillance and robotics, which are topics of prevailing discussion, requires an intercultural scrutiny. Information Ethics is posed as an endeavour to cope with the challenging problems of our digital age.

1. Introduction. Since the second half of the last century computer scientists, such as Norbert Wiener (1989/1950) and Joseph Weizenbaum (1976), called public's attention to the ethical challenges immanent in computer technology that can be compared in their social relevance to the ambivalent promises of nuclear energy. In the beginning the discussion was focused on the moral responsibility of computer professionals. But for scientists like Wiener and Weizenbaum the impact of computer technology was understood to be something that concerned society as a whole.

Half a century after Wiener's seminal work the World Summit on the Information Society (WSIS) developed the vision

"[...] to build a people-centred, inclusive and development-oriented Information Society, where everyone can create, access, utilize and share information and knowledge, enabling individuals, communities and peoples to achieve their full potential in promoting their sustainable development and improving their quality of life, premised on the purposes and principles of the Charter of the United Nations and respecting fully and upholding the Universal Declaration of Human Rights." (WSIS 2003).

The WSIS also proposed a political agenda, namely

"[...] to harness the potential of information and communication technology to promote the development goals of the Millennium Declaration, namely the eradication of extreme poverty and hunger; achievement of universal primary education; promotion of gender equality and empowerment of women; reduction of child mortality; improvement of maternal health; to combat HIV/AIDS, malaria and other diseases; ensuring environmental sustainability; and development of global partnerships for development for the attainment of a more peaceful, just and prosperous world." (WSIS 2003).

The academic as well as the social debates on these issues have increased rapidly particularly since the rise of the Internet. *Digital ethics* or *information ethics* can be considered in a *narrower sense* as dealing with the impact of digital ICT on society and the environment at large as well as with ethical questions dealing with the Internet digital information and communication media (digital media ethics) in particular. Information ethics in a *broader sense* deals with information and communication including -but not limited to- the digital media.

2. The global impact of ICT on society and the environment. Economic, political and

ecological activities of modern societies rely heavily on digital communication networks.

The relevance of digital ICT on the **economy** became obvious with the burst of the 2000 dot.com bubble. Its close dependence with the financialisation of economy as well as the transformation of economical activities in the last two decades leading to a increasing globalisation of the economical structure (Estefanía 1996, Ramonet 2004, Castells 2007) lead us to consider ICT as one of the main factors leading to the recent world economic crisis (Bond 2008). Beyond the moral individual responsibility of politicians, bankers and managers, there is a systemic issue that has to do with the digitalization of communication and information in finances and economics. Digital capitalism was and is still able to bypass national and international law, control and monitoring institutions and mechanisms as well as codes of practice and good governance leading to a global crisis of trust not only within the system but with regard to the system itself.

Many experts in politics and economic agree that in order to develop a people-oriented and sustainable world economic system, national and international monitoring agencies as well as international laws and self-binding rules are needed. Academic research in digital ethics should become a core mandatory issue of economics and business studies. Similarly to the already well established bioethics committees, ethical issues of ICT should be addressed taking as a model for instance the European Group on Ethics in Science and New Technologies to the European Commission (EGE; Capurro 2004).

ICT has a deep impact on **politics** leading to a transformation of 20th century broadcast mass media based democracy, or *mediocracy*, on the basis of new kinds of digital-mediated interactive participation. New interactive media weakens the hierarchical one-to-many structure of traditional global mass-media, giving individuals, groups, and whole societies the ca-

pacity to become senders and not "just" receivers of messages (→*message, dialogic vs discursive*).

We live in *message societies*. I call the science dealing with messages and messengers *angeletics* (from Greek: *άγγελία/άγγελος* = message/messenger) (Capurro 2003, →*angeletics*). New ICTs are widely used for political participation and grass-roots protest groups as well as by liberation and peace movements. By the same token, digital communication networks make possible new structures of political surveillance, censorship and control on individuals and whole societies. Digital ethics should address the question of the human right to communicate (→*Critical Theory of Information*).

The Internet has become a local and global basic social communication infrastructure. Freedom of access should be considered a fundamental ethical principle similar to freedom of speech and freedom of the press. Some of the rights stated in the *Universal Declaration of Human Rights* such as the right to freedom of thought, conscience and religion (Art. 18), the right to freedom of opinion and expression (Art. 19), and the right to peaceful assembly and association (Art. 20) need to be explicitly interpreted and defined taking the new and unique affordances of internetworked digital media into consideration. Lawrence Lessig (1999) envisaged a situation in which the universality of Cyberspace is endangered by local codes of the market, the software industry, the laws of nation states, and moral traditions. He writes:

> *"If we do nothing, the code of cyberspace will change. The invisible hand will change it in a predictable way. To do nothing is to embrace at least that. It is to accept the changes that this change in code will bring about. It is to accept a cyberspace that is less free, or differently free, than the space it was before."* (Lessig 1999, 109)

A free Internet can foster peace and democracy but it can also be used for manipulation and control. For this reason, a necessity to strive for a future internet governance regime

on the basis of intercultural deliberation, democratic values and human rights has been pointed out (Senges and Horner 2009, Capurro 2010).

Another issue arisen in contemporary societies concerns the impact of the **materialities of ICT** on nature and natural resources. Electronic waste has become major issue of digital ethics (IRIE 2009). It deals with the disposal and recycling of all kinds of ICT devices that already today have devastating consequences on humans and the environment particularly when exported to Third World countries. Issues of sustainability and global justice should be urgently addressed together with the opportunities offered by the same media to promote better shelter, less hunger and combat diseases. In other words, I advocate for the expansion of the human rights discourse to include the rights of non-human life and nature. The present ecological crisis is a clear sign that we have to change our lives in order to become not masters but stewards of natural environment.

3. Digital media ethics: an intercultural concerní. The main topics of digital media ethics or digital (information) ethics commonly addressed are: intellectual property, privacy, security, information overload, digital divide, gender discrimination, and censorship (Ess, 2009; Himma and Tavani 2008). However a more critical reflection -as previously argued- should also embrace issues concerning: economical responsibility, political participation and materialities of ICT.

All these topics are objects of ethical scrutiny not only on the basis of universal rights and principles but also with regard to cultural differences as well as to historical and geographical singularities leading to different kinds of theoretical foundations and practical options. This field of ethics research is now being called intercultural information ethics (Capurro 2008; Hongladarom and Ess 2007; Capurro 2006; →*Intercultural Information Ethics*).

One important challenge in this regard is the question about how human cultures can flourish in a global digital environment while avoiding uniformity or isolation. Research networks on Information Ethics are flourishing in Africa (ANIE: African Network for Information Ethics: ANIE) and Latin America (RELEI: Red Latinoamericana de Ética de la Información).

An example of the relevance of the intercultural approach in digital media ethics is the discussion on the concept of **privacy** from a Western vs. a Buddhist perspective. While in Western cultures privacy is closely related to the *self* having an intrinsic value, Buddhism relies on the tenet of *non-self* and therefore the social perception as well as the concept of privacy are different (Nakada and Tamura 2005; Capurro 2005). However, a justification of privacy from a Buddhist perspective based on the concept of *compassion* seems possible and plausible (Hongladarom 2007).

Digital surveillance of public spaces is supposed to ensure safety and security facing unintentional or intentional dangers for instance from criminal or terrorist attacks. But at the same time it threatens autonomy, anonymity and trust that build the basis of democratic societies (RISEPTS 2009). New technologies allowing the tracking of individuals through RFID or ICT implants are similarly ambiguous with regard to the implicit dangers and benefits. Therefore they need special scrutiny and monitoring (EGE 2005).

Recent advances in **robotics** show a wide range of applications in everyday lives beyond their industrial and military applications (ETHICBOTS 2008). Robots are mirrors of ourselves. What concepts of sociality are conceptualized and instantiated by robotics? An intercultural ethical dialogue – beyond the question of a code of ethics to become part of robots making out of them "moral machines" (Wallach and Allen 2009) – on human-robot interaction is still in its infancy (Capurro and Nagenborg 2009, →*roboethics*).

Another example is the question of **information overload**, which has a major impact in the everyday life of millions of people in information-rich societies (Capurro 2005b) giving rise to new kinds of diseases and challenging also medical practice (Capurro 2009). We lack a systematic pathology of information societies. Similarly the question of internet addiction particularly in young generations, is worrisome. For example there is a growing need for cell-phones-free times and places, in order to protect ourselves from the imperative of being permanently available.

The ethical reflection on these issues belongs to a theory of the **art of living** following some paths of thought by French philosopher Michel Foucault. He distinguishes the following kinds of technologies, namely:

"*technologies of production*, which permit us to produce, transform, or manipulate things,"

"*technologies of sign systems*, which permit us to use signs, meanings, symbols, or significations,"

"*technologies of power* which determine the conduct of individuals and submit them to certain ends or domination, an

"*technologies of the self*, which permit individuals to effect by their own means or with the help of others a certain number of operations on their own bodies and souls, thoughts, conduct, and way of being, so as to transform themselves in order to attain a certain state of happiness, purity, wisdom, perfection, or immortality." (Foucault 1988, 18)

How can we ensure that the benefits of information technology are not only distributed equitably, but that they can also be used by the people to shape their own lives? (Capurro 2005a; See also Capurro 1996; 1995; 1995a).

Another important issue of digital media ethics concerns the so-called **digital divide** should not be considered just a problem of technical access to the Internet but an issue of how people can better manage their lives using

new interactive digital media avoiding the dangers of cultural exploitation, homogenization, colonialism, and discrimination. Individuals as well as societies must become aware of different kinds of assemblages between traditional and digital media according to their needs, interests and cultural backgrounds (Ong and Collier 2005). An inclusive information society as developed during the WSIS must be global and plural at the same time. Concepts like *hybridization* or *polyphony* are ethical markers that should be taken into account when envisaging new possibilities of freedom and peace in a world shaped more and more by digital technology.

In a recent report on "Being Human: Human-computer interaction in the year 2020," a result of a meeting organized by Microsoft Research in 2007, the editors write:

"The new technologies allow new forms of control or decentralisation, encouraging some forms of social interaction at the expense of others, and promoting certain values while dismissing alternatives. For instance, the iPod can be seen as a device for urban indifference, the mobile phone as promoting addiction to social contact and the Web as subverting traditional forms of governmental and media authority. Neural networks, recognition algorithms and data-mining all have cultural implications that need to be understood in the wider context beyond their technical capabilities. The bottom line is that computer technologies are not neutral – they are laden with human, cultural and social values. These can be anticipated and designed for, or can emerge and evolve through use and abuse. In a multi-cultural world, too, we have to acknowledge that there will often be conflicting value systems, where design in one part of the world becomes something quite different in another, and where the meaning and value of a technology are manifest in diverse ways. Future research needs to address a broader richer concept of what it means to be human in the flux of the transformation taking place." (Harper, Rodden, Rogers and Sellen 2008, 57)

This remarkable quote from a meeting organized not by anti-tech humanists, but by one of the leading IT companies, summarizes the main present and future tasks of digital ethics as a critical interdisciplinary and intercultural on-going reflection on the transformation of humanity through computer technology.

4. Towards a common world: new risks, new responsibility. Humanity is experiencing itself particularly through the digital medium as a totality or system of interrelations. Who are we and what do we want to be as humanity? This question asks for a historical not a metaphysical answer. A negative vision of such unity are balkanisations and imperialisms of all kinds, including digital ones.

Whereas the digital technologies might diminish "vulnerability and commitment" (Dreyfus 2001), the global challenges (as those gathered in the UN Millennium Goals), bring about unpredictable dangers in which information technologies are undoubtedly involved (in both positive and negative aspects), and claim for a renewal of responsibility, regarding what technology we want, how we develop it, how we share it, how we use it. We might cope with all these challenges, which include inequalities, divides and injustices of many types, if we jump over the human wall, i.e. we consider our endeavour for *human* rights as a part of a wider objective for a common world where carefulness extends towards nature. And this carefulness itself, should jump over a formal strive for rights, probably needing a rebirth of carefulness -for instance in health care (Kleinman et al. 2006), for which a critical appraisal within digital environment is needed (Capurro 2010)- since needs, human or not, are much more than simple collections of data, requiring a careful *interpretation* process, a closer interplay among partakers (→*Hermeneutics*).

Digital globalization should make us aware of the human interplay with each other in such a common world instead of making of the digital perspective over our lives and over reality a kind of digital metaphysics or (political) ideol-

ogy. This relativization of the digital perspective has been called *digital ontology* (Capurro 2006).

Who are we in the digital age? As human cultures become digitally hybridized this process affects social life in all its dimensions as well as our interplay with nature. The key task of digital ethics is to make us aware of the challenges and options for individual and social life design. The digital medium is an opportunity for the subjects of the 21stcentury to transform themselves and their relations in and with the world. This implies allowing each other to articulate ourselves in the digital network, while taking care of historical, cultural and geographical singularities. An ethical intercultural dialogue is needed in order to understand and foster human cultural diversity. Hereby we must look for common ethical principles so that digital cultures can become a genuine expression of human liberty and creativity.

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(RC –ed.-; RC, JMD)

INFORMATION LITERACY (S. *alfabetización informacional*, F. *Maîtrise de l'information*, G. *Informationskompetenz*) [ICT, information society, globalisation, education] concept

Several terms such as information literacy, literacy in information and development of information skills or information competencies are used interchangeably to identify competencies, skills, aptitudes, knowledge, personal experiences and required values to access, use, and communicate information in any medium (digital or paper) for academic, research, professional or entertainment purposes.

Translating this term into Spanish has brought about different concepts and definitions such as information competencies (competencias informacionales), information literacy (alfabetización informacional), literacy in information (alfabetización en información). However, the term most frequently used in Spanish is "desarrollo de habilidades informativas" (development of information skills) (Lau, 2006). To refer to information literacy in Spanish, the acronym ALFIN is generally used. This acronym was coined by Félix Benito in 1995. In English, the acronym INFOLIT is generally used.

Information literacy is considered a means to develop one of UNESCO's four pillars for education in the 21st century: learning to know about something, long life learning, training

people to manage information needs to search, assess, use and optimize information to solve problems and make decisions. INFOLIT is considered a pre-requisite to participate actively and effectively in the knowledge society. Furthermore, it is part of the basic human rights for long life learning and promotes social inclusion in every nation. OECD and European Space of Higher Education include information literacy as one of the basic competencies for any citizen.

INFOLIT is understood as the knowledge and capacity to use in a reflective fashion, intentionally and ethically, the set of concepts, procedures, and attitudes involved in the process of searching, obtaining, assessing, using and communicating information through online and mainstream media. Literacy in information is a set of abilities that enable people "to recognize when information is needed and have the capacity to locate, evaluate and use effectively the needed information" (ALA, 1989). Literacy in information exceeds the concept related to user training and it affects content as well as pedagogy. It entails the development of technical skills required to access, analyze and assess information (Aragón, 2005).

Overall, the term "alfabetización", a translation from the English word "literacy", is applied to the capacity to use different media, technologies or languages. Thus, we can talk about technology literacy (capacity to handle information technology and communication), digital (hypertext media domain and Internet), audiovisual literacy (capacity to understand and criticize audiovisual media and languages), scientific literacy (science domain and its mechanisms to create, transmit and apply information) among others. A crucial objective of lifelong literacy entails digital and INFOLIT basic read-write literacy integrating this with lifelong learning.

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(EM)

INFORMATION MANAGEMENT (S. *gestion de la información,* F. *gestion de l'information,* G. *informationsmanagement*) [Business Informat-ics, Bussiness Management, Information Soci-ety, TIC] discipline

Information management, in the context of organizations, can be identified as the disci-pline that deals with everything related to ob-taining the appropriate information in the right way, for the right person, at the good cost, at the appropriate moment, in the right place and articulating all these operations for the development of correct action. In this con-text, the main objectives of the Information Management are: maximizing the value and benefits of use of information, minimizing the

acquisition cost, processing and use of infor-mation, identify responsibilities for the effec-tive, efficient and economic use of infor-mation and ensure a continuous supply of in-formation.

The Information Management has a close re-lationship with the discipline of Knowledge Management in the organizational context. The objectives of the Information Manage-ment focus on those processes related to stor-age, processing and dissemination of explicit knowledge that is represented in the docu-ments. However, in this context, knowledge management goes a little beyond the Infor-mation Management. This would be in charge of making all knowledge into corporative knowledge and disseminate it appropriately. It mainly deals with the pragmatic and strategic decisions relating to the creation, identifica-tion, capture, storage and dissemination the integrated knowledge in an organization. And finally, the development of these operations would be implemented in tume with the hu-man dimension of these processes, respecting and redesigning the necessary organizational elements.

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(MPM. –ed.-; MPM, MG)

INFORMATION FLOW (S. *flujo de información*, F. *flux d'information*, G. *Informationsfluss*) [transdiciplinary, semantics, situation theory] concept, metaphor

Contents.— *1) Information and information flow, 2) Defining information flow.*

There is no standard definition of "information flow", and neither there is of "information". Nevertheless, in ordinary life we seem to be in agreement with the meanings of information and information flow. A major problem is to know whether information flow is a concept or a metaphor. Here we are going to assume it is a concept.

While the concept of information is quite difficult to grasp, a definition of information flow in terms of information should not be that hard. Therefore, in this entry we propose an informal definition of information flow from the starting point of some elementary concepts in a well-established theory of semantic information: situation theory (Barwise and Perry 1983; Barwise 1989; Devlin 1991).

1. Information and information flow. Situation theory distinguishes between information and information flow (Devlin 1991: 142-144). The basic assumption is that information is abstract and can be used for classifying concrete states of affairs. On this assumption is built up the following distinction:

There is *information* about a state of affairs as long as we can classify it by means of abstract states, such as vectors, time periods or logical formulae. We then say that the state of affairs*supports* certain information. Example: we have information about the waitress in that we know that his hands are muddy.

There is *flow of information* from one state of affairs to another as long as some way of classifying the first one indicates some way of classifying the second. Then we say that the first

state of affairs *carries* information about the second one. Example: the fact that the waitress' hands are muddy carries the information that my plate is possibly muddy.

In theories prior to situation theory this distinction was not always taken into account. Neither it is clearly stated in recent proposals like that of Floridi (2005). On the other hand, whenever the flow of information is on the focus two typical problems arise immediately:

Is it required the existence of agents for the flow of information to take place? Usually this question is answered in an affirmative manner. Situation theory gives for granted their existence in despite of some occasional debate on this matter. Channel theory (Barwise and Seligman 1997), on the contrary, doesn't mention agents very frequently. Dretske (1981) is not completely clear. On the one hand he defines the flow of information through the notion of an external observer: "A state of affairs contains information about X to just that extent of which a suitable placed observer could learn something about X by consulting it" (Dretske 1981: 45); on the other hand, he states that information is an agent-independent phenomenon. Floridi (2005) distinguishes between *semantic information* (which is agent-dependent) and *environmental information* (which is agent-independent).

How to explain the properties of the flow of information? Pérez-Montoro (2007) offers a comprehensive discussion of both these properties: relativity (the same state of affairs might carry different pieces of information to different agents), and fallibility (sometimes a state of affairs do not carry the information it is supposed to carry). Almost any author tries to explain those properties, which in turn exhibit different names as well as diverse formulations.

2. Defining information flow. Now then, neither in situation theory nor in further theories information flow is defined as such. It is only said that there is flow of information whenever some states of affairs carry infor-

mation about each other. A definition of information flow must be therefore based on the concept of information.

If we call "distributed system" to any collection of states of affairs that are able of carrying information about each other (Barwise and Seligman 1997), and we call "information transfer" to the fact that -with respect to a distributed system- a state of affairs actually informs about another one, then *we can define the flow of information within a distributed system as the class of all its information transfers with respect to certain analysis of the system as well as certain period of time.* This definition has the advantage of conforming with common sense and with some basic yet fundamental concepts of situation theory.

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(JO)

INFORMATION REPORTS (S. *enunciados de información*, F. *rapports d'information*, G. *Informationsberichte*) [transdiciplinary, semantics, situation theory] concept

Contents.— *1) Definition, 2) Remarks, 3) Methodological relevance, 4) Examples.*

1. Definition. In a broad sense, an information report is one of these two things: (i) A report in which either the noun "information" or the verb "to inform" or the adjective "informative" or some other derivative appears. (ii) A report that can be paraphrased into a report of the first sort.

Examples: "*a* informs to *b* about *p*", "database DB1 contains more information than database DB2", "information source S1 is less reliable than information source S2", "it is illegal that *a* conceals from *b* the information *p*".

In a narrow sense, an information report is any report that (iii) either exhibits the form "signal *s* carries the information *p*", (iv) or can be rephrased in such a form.

2. Remarks. We are not dealing with standard defitinitons as there is not a well established theory on information reports and their semantics. The definition in a broad sense tries to gather diverse contributions of the technical literature since at least Fox (1983).

An information report in a narrow sense is but a variety of information report in a broad sense. But the influence of Israel and Perry (1991), where the former are defined, justifies the distinction.

The reduction from (ii) to (i) and from (iv) to (iii) is not always so clear, therefore it is convenient to center on (i) and (iii) up to grasping well the information concept. However, there are clear cases of possible reduction, as it happens with reports like "*s* means *p*" as they are studied in Grice (1957) or Barwise and Perry (1983).

3. Methodological relevance. In analytical philosophy it is usually argued for (Fox 1983: 20-29) that any conceptual investigation on information must begin with a prior study regarding information reports. This does not imply resigning from the study of concepts and realities in favor of a mere study of language. The strategy is to take the language as a starting point. First it is agreed that reality X is the meaning of expression "X". Then the linguistic uses of "X" are discussed, since this is a more objective field than that of the direct discussion about X. Finally we come back to

the study of X, this time from an intersubjec-tiveagreement and conceptual delimitation that stems from the previous discussion about the uses of "X".

4. Examples. Since there is no standard theory regarding information reports, it is more secure to introduce them trough concrete examples instead of displaying from the very beginning a tentative classification. Let's see two of them. The first one comes from Israel and Perry (1991), the second from Floridi (2006). The former example assumes some knowledge on propositional attitude reports (McKay y Nelson 2008). The latter requires some basics on modal epistemic logic (Hendricks and Symons 2009).

Example 1: "signal s carries the information that p"

Israel and Perry (1991) devotes its first section to the logical-linguistic study of information reports. Paradigmatic examples are:

(1) "The x-rays indicates that Jackie has a broken leg."

(2) "The fact that the x-ray has such and such a pattern indicates that Jackie has a broken leg".

Both in (1) and in (2) the initial noun phrase plus the verb or verb phrase form the *informational context*, the proposition designated by the that-clause is the *informational content*. The object designated by the initial noun phrase of (1) is the *carrier* of the information; the fact designated by the initial noun phrase of (2) is the *indicating fact*.

Some important properties of informational contexts:

They are factive: if an information report is true, its informational content is true too.

They are not truth-functional: given "s informs that p" and the logical equivalence between p and q, one does not conclude "s informs that q".

They distribute across conjunction: if "s informs that p and q", then "s informs that p and s informs that q".

They do not distribute across disjunction: given "s informs that p or q", one does not conclude "s informs that p or s informs that q".

They are opaque with respect to definite descriptions: given "s informs that c holds the property P" and the equality c = "the x that holds Q", one does not conclude "s informs that the x that holds Q also holds P".

Some analyses of information reports based on Israel and Perry (1991), like e.g. Barwise and Seligman (1997: 12-13), take any report of type (1) to be an abbreviation of some report of type (2). Such analyses are usually based on Dretske (1981).

Example 2: "agent a is informed that p"

Floridi (2006) establishes three different ways in which an agent a can be related to an information piece p, the latter being a contingently true proposition. These three relations can be seen like interpretations of the expression "the agent a is informed about p".

Being informative: Evaluation of that situation in which p brings information to the agent.

Becoming informed: The process by which the agent gets the information p. The result of this process is the situation in which the agent is informed.

Being informed: The cognitive state of the agent by virtue of which it possesses the information p. It can be seen as the result of the action of becoming informed.

Of these three interpretations Floridi (2006) focuses only on the third one. He wonders if there exist modal logics whose modal operator $I_a p$ could be read as "the agent a is informed that p". If that is the case, those logics would be comparable to the modal doxastic logics KD, KD4 and KD45 (where $B_a p$ means that a believes that p), as well as to the modal epistemic logics KT, S4 and S5 (where $K_a p$ means that a knows that p). The proposal of Floridi (2006) is to interpret the modal logic KTB as the best formal model for the relation of "being informed".

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(JO)

INFORMATION RETRIEVAL (S. *recuperación de información*, F. *recherche d'information*, G. *informationswiedergewinnung*) [information management, LIS, linguistics, Informatics] concept

Contents.— 1) Changes in the meaning of the term, 2) Information Retrieval and Knowledge Retrieval, 3) Information Retrieval Language and Information Retrieval Systems, 4) Metadata, descriptors, and indexing, 5) Information retrieval by controlled vo-cabularies, 6) Relevance, 7) Retrieval Measures, 8) Retrieval Models.

Information retrieval is the set of activities that facilitates the searching and retrieval of data. Information retrieval comprises techniques from linguistics, computer science, information science, and text mining.

1. Changes in the meaning of the term. In the first place, the term only was used to denote the set of techniques and process aimed to retrieve data from data bases in computer systems. In the early nineties, with the increasing amount of text documents in the Web, text retrieval becomes the main goal of these techniques. Most of these tools look for finding words in common between the textual query and textual documents. As multimedia resources growths in Internet, search engines begin to search audio, images, and video resources. In the literature, document retrieval, text retrieval, information retrieval, and data retrieval are often employed as equivalents, although, indeed, each one has a specific meaning.

Traditionally, in the Web context the answer to a query is a set of documents that probably have relevant data about the topic. Another related area is question-answering systems that answer to a query just with a specific data, and not with a set of documents.

2. Information Retrieval and Knowledge Retrieval. Usually, information regards to what is and which properties has something. In other words Information is related to definitions. But Information seldom cares about how relate with other information elements, in a specific context. The integration of information items among them is what is regarded as knowledge. So, an explicitation of know-how has to define how the items are related and how the process is developed. This approach assumes two important concepts to perform a task: the existence of a goal and the existence of relationships in the system among the concepts. On one hand, the existence of goal implies a purpose and necessity to achieve a goal. This goal only exists in living beings. Therefore the Knowledge retrieval has sense just in the brain of the human being that performs the query. On the other hand, knowledge implies that the information is interrelated to archive the goal. So, the information is related by means of a set of rules and restrictions. The inclusion of these rules in computer applications is the reason to change

the name from Information Retrieval Systems to Knowledge Retrieval Systems. These systems have their origin in the Artificial Intelligence (AI) field. AI tries to emulate human reasoning, and this involves having finalities, rules, and relationships. Intelligent agents and ontologies are necessary resources to emulate the human brain. These resources induce to rename information retrieval to knowledge retrieval. Knowledge Retrieval Systems tries to implement search engine that search not only words in the documents, but process, and even inference data.

3. Information Retrieval Language and Information Retrieval Systems. The fact that Information Retrieval regards to computer systems (in contrast with library methods that have a wider meaning) causes that some retrieval languages are linked with a specific technology or system. Some well-known retrieval languages are SQL, SPARQL, Boolean, etc.

4. Metadata, descriptors, and indexing. In the 60s and 70s, computers had a limited storage capacity and the speed to compute was low. Document in these systems need to represent its content with metadata and a small set of terms, called descriptors. Metadata used to be author, title, source, and date. Metadata and descriptors assignment was by-hand.

Nowadays, these metadata are used in the Semantic Web because of their simplicity, facilitating its interoperability and navigation in the Web.

Automatic indexing deals with the techniques to assign automatically relevant terms to a document. Relevance is computed by means of statistics and the term location in the document. Examples are term frequency and Inverse Document Frequency (known as tf-IDF), stop-word removal or, higher weight of the words from the title or with stressed typographically (e.g. bold letters). Most of these factors are used in web search engines.

5. Information retrieval by controlled vocabularies. In Information Science, terms from a specific domain often are listed, in a normalized way. This list is called controlled vocabulary, and each descriptor is known as descriptor. This vocabulary could present relationships among terms. Vocabulary control tries to avoid typical problems in natural language: polysemy, homonyms, and synonyms.

Relationship types in these vocabularies might present different nature. In thesaurus relationship are equivalence, hierarchy, and semantic relatedness. Faceted thesaurus shows different scopes to facilitate retrieval.

6. Relevance. Relevance is a measure about the degree a certain element answer to a query. This measure is subjective, in the sense that depends on the knowledge of the person who assesses the relevancy.

7. Retrieval Measures. Performance of an information retrieval system might be measured by the retrieved data/documents. There are two coefficients:

— Precision: proportion of relevant data retrieved from the total data retrieved.
— Recall: extend of relevant data retrieved from the total of data relevant in the Data Base.

Both measures have an inverse relationship (Cleverdon Law). Increase precision produces a decrease in recall. These coefficients measure two different factors: noise and silence.

— Noise: non-relevant data retrieved
— Silence: relevant data that have not been retrieved from the data base

Compute recall implies to know how many elements are relevant to a specific query in the data base. This relevance list is called test collection, and it is made by-hand. Test-collections are used in international competitions to test retrieval systems. TREC (Text Retrieval Conference) is the best known conference about retrieval.

8. Retrieval Models. Retrieval models compute the degree that certain elements answer to a query. As a general rule it is computed by

means of a similarity coefficient (Cosine, Phi, etc). Most popular models are:

— Boolean: only two values are computed, relevant/non-relevant. Only relevant document are retrieved without any order. An example is SQL in relational data bases. Although there is an extended boolean model to provide a way to sort results.
— Vectorial: A vector is built to represent the terms that every item has. The query vector and every document vector are compared, measuring the grades that are between them.
— Probabilistic: the probability of a document to answer to a query is computed. Often is used retrieval feedback to improve the probability estimate. Feedback is based in user judgments about the set of document retrieved. Words from positive results are given a higher value when the query is recomputed.

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(JML)

INFORMATION VISUALIZATION (S. *visualización de información*, F. *affichage d'informations*, G. *anzeigen von Informationen*) [Research and practices] concept

Information Visualization is the discipline that deals with the visual representation of propositional content by using charts, graphs and diagrams in order to facilitate the apprehension, interpretation, transformation and communication of those contents through these visual representations.

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(MPM. –ed.-; MPM, MG)

INFORMATIONAL CONTENT (E. *contenido informacional*, F. *contenu informationelle*, G. *Informationeller Inhalt*) [semantics of information, situation theory] concepto

The main references for the notion of informational content are the works of Fred Dretske. According to him, the ideas of Shannon and Weber can be adapted in order to characterize what can be the informational content of a given signal. Dretske's proposal is the following one. A signal s coming from a certain source S and registered by a certain system R having some knowledge K about S (for instance, that S can be F or G or H) would have the informational content that S is F if and only if the probability that S is F, given s and K, is equal to 1. Other proposals have been made in the context of teleosemantical approaches, like the one favoured by Millikan, and in the context of the "situation theory" elaborated by Barwise and Perry.

Because of the way they are defined, informational contents would be very wide and they cannot be erroneous. In contrast with informational content, →*semantic content* is very specific and it can be erroneous. In particular, that would be so with respect to the semantic contents associated with propositional attitudes.

Informational content would be converted into a semantic content through the intervention of functions. When there is the function of bearing some information in particular, then informational content can be made narrow and the relevant information can be activated in an erroneous way. Dretske's approach considers three ways in which such functions can be introduced: 1) as some sorts of natural functions selected by biological evolution, 2) as some sorts of attributed functions created by artificial design, and 3) as some sorts of functions acquired by individual learning.

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(ML)

INFORMATIONISM (S. *informacionismo*, F. *Informationism*, G. *informationismswissenschaft*) [transdisciplinary, ICT] theory

Contents.— *1) Introduction, 2) Historic evolution, 3) Evolution in the XIX, XX and XXI centuries, 4) What is understood by "information", 5) Neuronal theory: quanta of useful information. 6) Neuronal theories of information, 7) Other interesting theories, 8) Informationism: former theories, 9) Informationism: a new theory of knowledge, 10) Conclusions.*

An epistemology, based on the information that rules our lives, is stated –Informationism-. Information, or perhaps the message, reaches

the brain as tiny impulses –quanta or useful information–, hitting and activating the neurones; as a consequence becoming quanta of useful information. Among other matters, human neural evolution due to information, as well as other neural information theories are studied.

1. Introduction. In these historic times of change in social structures, a transmutation process is taking place which affects all human manifestations. Its main influence can be seen in the conceptual principles related to the theoretical basis of many scientific disciplines. Considered as a whole as an essential element, information is also affected by the transmutations that are currently taking place. Neuronal Information Assimilation theories are studied.

2. Historic evolution. Descartes (1596- 1650 AD) in his famous statement "I think,therefore I am", he grants an absolute value to human thinking, valid by itself; which confers nature to the being. This "thinking" is reached through a process of assimilation of information producing knowledge. The point of view of Cristoph Martin Wieland (1733-1813 AD) which deals with information, with the understanding and the information of the heart is also interesting.

In the Oxford English Dictionary, there is a great deal of definitions for information, dating from the XIV century. Apart from pointing out information as an element to form the mind, to teach and to learn, it mentions its function as an advice,as a warning; as well as in legal terms.

3. Evolution in the XIX, XX and XXI centuries. It may have been at the end of the 80's in the XX century, - one has to be cautious with these statements - when the neurological connotations of information started to be studied as such - neural assimilation -, along with its connection with theology and hermeneutics.

All these studies are carried out at the same time as the development of computerized

communication techniques, computer science, and all that is related to computational science.

4. What is understood by "information". Information is both "everything" and "nothing" at the same time. On the one hand, it is indeed "everything", due to the fact that, through its mental or physical use, one can reach knowledge and, from that, taking as an example its most pragmatic sense, research, science, wisdom and the truth - objective, relative and conditioned truth -. From this reasoning, it can be concluded that information has a transcendental connotation, given that, following the same line of thought; from truth one can reach evidence and certainty.

5. Neuronal theory: quanta of useful information. The theories stated the fact that impulses from the outside are received by neurons, which thus start their activity. In other words, neurons are activated, giving the individual – the human being – a higher reasoning capacity and intelligence.

The signals coming from outside the brain formed small "quanta of information" which were immediately followed by the processes mentioned above to develop knowledge and subsequently ideas, becoming "quanta of useful information". And this is a phenomenon that has been occurring since Man became Man, or maybe even before that. Helmut Anntz affirms that hominid became human exactly due to the consecutive reception and assimilation of information, reaching its brain from the outside, from its environment.

6. Neuronal theories of information. Therefore, we know that information is processed - neuronal assimilation - when certain impulses, or quanta of useful information, reach the brain, thus giving rise to knowledge: a useable product. Several authors have done research on this significant subject and have developed different theories which I can today describe as "neuronal theories of information".

In order to study some neuronal theories, one has to go back to the middle of the XX century

when C. E. Shannon published his Theory of Information, which can be considered as the starting point. Somewhat later, in 1988, I had the satisfaction of releasing my theory of the quanta of useful information. Since then, many different theories have been developed. Most of them try to find some parallelism between the processes occurring in the brain and the mechanisms carried out by computers; in accordance with some programmes prepared beforehand, in order to have the machine carrying out the function for which it was manufactured (– by human beings – note of the author). Some authors think that the process has been carried out the other way round; i.e. it was the machines' operation that induced the thought of a similar operation in the brain. In any case, these theories have been developed by different specialists and researchers of the field of information science.

In order to study the mentioned process of neuronal assimilation, we will expound some relevant opinions, considered as the starting point of subsequent researches. On the one hand, John McHale considers information is a consumer good, which humans should use to their benefit and to obtain better living standards. He assumes living beings use their senses to collect information from the environment and the difference between human beings and other living beings is that man can "process" information consciously; humans use a system of symbols to communicate with fellow men. The author also mentions the changing and changeable environment of information - note of the author -; since he assumes that it is due to its influence and use that our life conditions, basic principles, cultural manifestations and so on vary. The use of information to a greater or lesser extent measures the level of evolution of the human race. More informed societies will have more possibilities for choice.

On the other hand, Fred I. Dretske grants information a holistic, primal and basic nature. He states that, in the beginning, there was information and the world came after it. The transition, (perhaps better transmutation –

note of the author), was carried out through the development of organisms with the ability of exploiting information in a selective way, with the purpose of being able to survive and endure as a species. Information reaches the brain and affects and activates the neurons. For a reaction to happen, the brain needs a reference scale; which is built through consecutive information reaching it from the outside world. These theories seem somehow incoherent to me, since the question about the origin of information arises. If the world has risen from information, perhaps the idea of an all-embracing creator loses strength… or is information then the creator?

Another interesting researcher is Thomas J. Froelich, who deals with information as an element to develop knowledge, subsequently studying the latter. He states thought is not absolute; it depends on the nature of each individual, on its reference system and on its set of values. Nothing new so far; but he carries on with the statement that thought can always and only be valid from the point of view of the individual thinking it. Therefore the famous sentence of Descartes needs to be inverted, thus considering: "I am, therefore I think". Thinking is a human activity and it implies information as an element, cause and effect. This activity grants a social function to thinking. Each society - social group - creates a different form of knowledge and thought.

7. Other interesting theories. Similarly, the theories of R.M Berstrom are interesting. According to him, humans behave as a communication system, at the centre of which is the brain. Here, the signals are received from the outside and emitted to the outside. Information is supposed to be the raw material to develop these abilities. The author also states one needs to make the difference between information and the processing of it. Through subsequent reasoning, the difference between "information" and "information science" can be established. As several other authors maintain, Bergstom compares the brain with the machine - perhaps the computer -, stating that information is the raw material driving both

and thus comparing information with energy. The informative capacity of the brain, within the brain structure, is estimated to be generated at approximately 109 bits/sec. However, when it reaches the conscious level it is only about 100 bits/sec, which means there is a loss of 107 bits/sec when going from the physiological to the psychological level. Human beings have the capacity for a higher brain development; to be more intelligent. The mechanism to go from the sphere of the "unconscious" to the sphere of the "conscious" is missing.

The theories of Brier will now be considered. He deals with the interpretation of the message, different from the information; in order to make it understandable and comprehensible by the receiver. The brain, together with the machine, is responsible for this comprehension, in which a cognitive process is included. Brier, together with M. Leupolt and other researchers, amongst whom I am included, is of the opinion that this cognitive process should be extended to every living being, i.e. plants and animals.

Alexander King assumes there is a series of phenomena, events and stages of understanding, each of them at a higher and more complex level of abstraction, in order to reach the "knowledge" of the world we live in, and to adapt our acts to this world. Information is in every one of these stages, either as a base or as a vehicle to pass from one level to the other. These theories are actually shared nowadays by several specialists and researchers. What was new about them was the historic moment in which they appeared. Alexander King was one of the pioneers and he is well known for his many works and papers.

From the principal theories of Norbert Henrichs, it is worth mentioning here his interest in the creative ability of human beings, which enables them to reach science and, therefore, wisdom. This author also focuses on the spiritual attributes of information and, to a certain degree, grants it theological connotations.

Amongst other opinions and research from the theories of Peter Ingwersen, we could stress those in which research is considered as the result of a modification of the structures of knowledge of who receives the information – supposedly a human being.

From either point of view, neuronal theories are based on the same principles and follow almost identical reasoning. Perhaps A. N. Leontiev contributes with something new, by relating information to conscience, and assuming information is in fact the way in which conscience exist for the others. Apart from that, information is the link between individuals; obviously in a process of communication.

8. Informationism: former theories. After what has been written until now, it would seem unnecessary to continue justifying the possibility of formulating a new epistemology based on information: informationism. However, it may be convenient to establish relationships with other theories on knowledge organization, in order to observe perhaps the parallelism between these and information, taken now as a mental process.

On the one hand, information arrives to the brain, and activates a mental process which starts with the seizure, reaching knowledge and then comprehension, to end up with a total understanding of whatever was involved by the information in the origin. All this implies a process of organization of knowledge itself. On the other hand, information is considered to be the connecting thread which affects the brain of human beings, helping them to form their intelligence. Each historical period has based its knowledge theories on a different principle, which is itself influenced by the stage of the actual evolution of mankind. Similarly, the philosophical trends being studied by men from different points of view have had an influence; different theories have thus raised, such as causalism, empiricalism, positivism, historicism, physicism and so on.

The relationships that may be applied between some of these known theories and information are now considered. Firstly, "causalism" which states there is no effect without a cause: effect = quanta of useful information reaching the brain; cause = knowledge. Realism states that real objects are the base for knowledge. Here, an idea corresponds to an object and the former has its origin in information, which will thus become the object. Positivism is the theory which matches the best. It was devised by August Comte, and based on the concept that only the facts, immediately received by the senses and quantitatively verified, can generate knowledge. This author also allows for a social attitude, given that the perception of the outside world may condition our behaviour.

In the past, perhaps since 1980 to mention a guiding date, the chemical and spiritual components of human beings have been being considered; this implies a change in the postulation of such theories. A modern theory of knowledge has subsequently risen, based on the principle of "get to know you", which has lately gained great importance. This principle studies and examines in human beings, both physically and psychologically, in a neo-realistic attempt to turn the activities of the spirit into mere equations, and chemical and physical formulae; arguing that a human being is formed by chemical elements and compounds.

More recently, a turn towards a more humanizing position is being observed. Let us, for instance, quote Fernando de Elzaburu, who bases his theory of knowledge organization on the change of paradigm of his new "vision of reality". We live in a transmutation period and, therefore, old reference parameters are no longer valid. Other more highly abstracted parameters, based on system theory, should be accepted. Norbert Henrichs also develops his theory from a change of paradigm, by adding a phylo-theological connotation to information, based on obtaining "wisdom" –more complex than "knowledge"-; subjective and relative knowledge, since it is human, but objective and absolute with respect to its relationship with science –note of the author–. Jirî

Cejpek's sets his paradigm on human conscience, as a psycho-physical phenomenon carried out in the brain when it receives information. Many other formulations, by many other authors, and deducible from the ones already mentioned, could be quoted here.

9. Informationism: a new theory of knowledge. Even though it is widely admitted that we are currently living in the Age of Communication, given that information flows back and forth through communication; it is obvious that information surrounds and invades us. Not even on a desert island could

we escape its influence. Information is the basis for any human activity, for all our reasoning, the origin of any social attitude; it is the basis... It is the basis on which to formulate a theory of knowledge, which takes information as fundamental paradigm, and which I call "Informationism".

On the one hand, Informationism entails an optimistic viewpoint, through the belief that a more equal and homogeneous world can be achieved, if its paradigms are correctly applied. On the other hand it implies a waiting and hoping attitude, given that it implies an uncertainty before the truth is revealed. Informationism also assumes a functional principle of thinking, a philosophic and scientific activity, with its repercussion on scientific development. Moreover, it affects daily activities, such as trade and industry. Its influence can be observed in ethical and cultural behaviours. It also has an effect on pragmatic activities such as decision-making, for instance. Having an attitude based on Informationism means perceiving the world from a higher level, on which a broader range of concepts is observed; a higher level of abstraction.

Informationism is an objective in itself. It relies, in each particular case, on real and objective reasoning, based on the existence of also real and objective information, hence true information. Therefore, Informationism is also true and real. These rather deterministic attitudes; stating a totalitarian view of information as the seed of "all" that happens in the

Universe, within which is Planet Earth and the rest of the cosmos, leads one to consider Informationism from its pantheistic aspect, of globalizing connotations, considering this as a positive view. Informationism can thus be considered to have positivistic attributes.

It is deduced that Informationism can be described as human, objective, realistic, optimistic, globalizing, philosophical, scientific, pragmatic ,real, terrestrial, cosmic... pantheistic; all "good" qualities anyway. Some researchers and specialists may not agree with this classification and theories... let us await their reactions.

In any case, it can be stated that Informationism period has arrived.

10. Conclusions. We live in a constantly evolving world, which leads to a continuous transmutation as well. In the past twenty years or so, to set a date, there have been greater transmutations than in the fifty years before. Information technology has been the cause of all these changes. We do not even know ourselves, neither do we get to specify our attitudes towards machines, faced with a computer for instance. What an amazing change in the way we do some research, write a conference paper or send a letter to a friend! Machines and electronic devices would not have gained such importance in our lives... if it were not for the influence of a driving force... towards change. Here is just where information has its place, exactly in this driving force, which is mainly determined by two specific factors: quantity on the one hand, and speed on the other, in which human beings are immersed. We live rushed lives. We are in a hurry to do everything; even, or maybe due to that, to control the amount of information surrounding us.

Ours is a changing world, influenced by information. It is information itself which leads us to understand that our fields of consideration; our points of view must be broadened. Everything is related to everything; and to be able to distinguish what captures the relevance, the at-

tention or the interest, a higher degree of abstraction needs to be reached. Things need to be looked upon from higher above; a higher level of thought needs to be reached... Likewise, there should be the aspiration of reaching a Cosmo vision... with higher level of abstraction.

Since the appearance of information was shown up: due to the influence on the brain of impulses coming from the outside - quanta of useful information -, thus reaching the neurons and activating them, nearly all definitions found consider this aspect; and then the anthropological, neurological, biological, ontogenetical, epistemological, and theological connotations appeared. Regarding this, our colleague A. García Gutiérrez mentions "bio information".

Information, as an all-time route of civilization, is also analyzed. It is supposed to belong to the mesosystem, within the noosystems. And there is also here an induction to consider the validity of Informationism: a new epistemology, based on the paradigm of the universality of information.

A new area of knowledge is emerging, independent in itself, but systematic and vertically related to the rest of the scientific areas of knowledge; that is to say, Information as a science in itself.

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(EC)

INPUT vs OUTPUT (S. *entrada vs salida*, F. *entrée vs sortie*, G. *Eingabe vs Ausgabe*) [System Theory, economics] concept

Input and Output represent the (unidirectional) connections of a dynamic system resp. of its elements with its environment. Usually there is more than one input and output of a system. While inputs represent influences from the environment to the system, outputs represent the effects of the system on its environment. If there is no connection between the system and its environment, the system is called closed.

The relation between input and output of a system is of particular interest. By the assumption of the black box hypothesis (ignoring the inner structure and relations of the system) one can try to analyze the output of the system in its response to a change in the input. If a deterministic system always responds to all certain inputs in the same way the system is called passive, if not, it is called active. If the relations between input and output are stochastic in nature, one can study the conditional probability distributions of the output to get more information on the system.

Input-Output Analysis, developed by Nobel Laureate Wassily Leontief (1905-1999), is a method to study economic systems on a local, regional, (mainly) national or global basis. With the help of an Input-Output Table (listing the value of intermediary goods and the value added for each firm or industry) one can predict the effects of final demand (consumption, investment, foreign trade) on total output. Economical input-output analysis goes back to Francois Quesnay (1694-1774) who as surgeon in ordinary to king Louis XV of France was inspired by blood circulation and developed the first tables of an economy. Leontief did not start from scratch. He expanded Marx' reproduction schemes and the planning tools of the former Soviet Union up to a point where Input-Output Analysis became applicable empirically.

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(PF)

INTERCULTURAL INFORMATION ETHICS (S. *ética intercultural de la información*, F. *Éthique interculturel de l'information*, G. *Interkulturelle Informationethik*) [Information ethics, Information Society] discipline

Contents.— *1) Erecting a new discipline, 2) The foundational debate (2.1 On the Sources of Morality, 2.2 On the Foundation of IIE —Charles Ess, Toru Nishigaki, Terrell Ward Bynum, Bernd Forman, Luciano Floridi, Philip Brey, Rafael Capurro), 3) Debate on IIE*

Intercultural Information Ethics (IIE) can be defined in a narrow or in a broad sense. In a narrow sense it focuses on the impact of information and communication technology (ICT) on different cultures as well as on how specific issues are understood from different cultural traditions. In a broad sense it deals not only with intercultural issues raised by ICT but by other media as well allowing a large historical comparative view. IIE explores these issues under descriptive and normative perspectives. Such comparative studies can be done either at a concrete or ontic level or at the level of ontological or structural presuppositions.

1. Erecting a new discipline. The international debate on →*information ethics* started with the "First International Congress on Ethical, Legal, and Societal Aspects of Digital Information" organized by UNESCO in 1997.

Subsequent UN conferences culminated in the World Summit on the Information Society. The academic debate on intercultural issues of ICT takes place in the biennial conferences on "Cultural attitudes towards technology and communication" organized by Charles Ess and Fay Sudweeks since 1998. But intercultural issues are also raised in the ETH-ICOMP conferences organized by Simon Rogerson since 1995, the conferences on "Ethics of Electronic Information in the 21st Century" at the University of Memphis since 1997, and the CEPE conferences (Computer Ethics: Philosophical Enquiry) since 1997.

The first international symposium dealing explicitly with intercultural information ethics was organized by the International Center for Information Ethics entitled "Localizing the Internet. Ethical Issues in Intercultural Perspective." It took place in Karlsruhe (Germany) in 2004 (Capurro et al. 2007). The Oxford Uehiro Centre for Practical Ethics organized an international conference, entitled "Information Ethics: Agents, Artefacts and New Cultural Perspectives" that took place in 2005 at St Cross College Oxford. This conference addressed cultural questions of the globalization of information processes and flows, particularly "whether information ethics in a global sense may be biased in favour of Western values and interests and whether far-eastern cultures may provide new perspectives and heuristics for a successful development of the information society." (Floridi/Savulescu 2006, 155). Soraj Hongladarom and Charles Ess have edited a book with the title "Information Technology Ethics: Cultural Perspectives" (Hongladarom/Ess 2007). The book puts together a selection of contributions on what Western and non-Western intellectual traditions have to say on various issues in information ethics, as well as theoretical debates offering proposals for new synthesis between Western and Eastern traditions.

In the following, an overview on IIE as discussed in some of these sources is presented, dealing with the foundational debate in moral philosophy in general as well as with IIE in particular.

2. The foundational debate

2.1 On the Sources of Morality. There is a classic debate in moral philosophy between cognitivism and non-cognitivism with regard to the truth-value of moral claims. This distinction presupposes that human emotions have no cognitive value and vice versa, that human cognition has a truth-value if and only if it is free of emotions. According to Capurro (2009), this is a wrong alternative since, on the one hand, there is no emotion-free cognition; on the other hand, emotions have a cognitive value as demonstrated by neurobiologist Antonio Damasio (1994).

One classical answer to the question of the foundation of morality is that moral claims relate to the basic moral principle "do no harm, help where you can". Capurro believes that even if we can give good reasons for such a fundamental moral principle, the knowledge of such reasons is not enough to move the will in order to do (or not) the good. Is there a foundation for this principle?

According to Karl Baier (2006), basic moods through which the uniqueness of the world and the finitude of our existence become manifest, are a transcultural experience common to all human beings. They concern our awareness of the common world. It is on the basis of the mood of anxiety, for instance, that we are aware of death and finitude or in the mood of "being born" in which we feel ourselves open for new possibilities of being. According to Heidegger (1987, 228ff) fear is a mood in which one is afraid about something fearsome, while anxiety, in contrast, faces us with our being-in-the-world itself. Wittgenstein describes his "key experience" ("mein Erlebnis par excellence") in the "Lecture on Ethics" with the following words:

> "This experience, in case I have it, can be described most properly, I believe, with the words I am amazed about the existence of the world. Then I tend to use formulations like these ones: 'How

strange that something exists at all' or 'How strange that the world exists'''. (Wittgenstein 1989, 14, trans. Capurro)

According to Wittgenstein we have really no appropriate expression for this experience – other than the existence of language itself. On December 30, 1929 he writes:

"I can imagine what Heidegger means with being and anxiety. Human beings have the tendency to run against the boundaries of language. Think for instance about the astonishment that something at all exists. [...] Ethics is this run against the boundaries of language." (Wittgenstein 1984, 68, trans. Capurro)

In other words, the primum movens of moral actions lies in the call coming from the uniqueness of the world and the finitude of human existence that are disclosed through moods. According to Heidegger we are "indebted" or "guilty" towards the calling of the world, in the various senses of the word "guilty" such as 'having debts to someone' or 'being responsible for' (Heidegger 1987, 325ff) We are primordially "guilty" in the sense that we are indebted to the "there" of our existence, between birth and death. Our existence is basically "care" of our given and limited possibilities that manifest themselves within the framework of the uniqueness of the world and human existence.

Morality arises *from* (Greek: *"hothen"*) the awareness and respect for both the uniqueness of the world itself and human existence which are the invaluable and theoretically non provable truth-values on which all moral claims rest. The moral imperative is the call for care of our lives in a common world. It is a categorical imperative since there is no way to avoid caring for our lives, but it allows at the same time different interpretations that we accumulate as individuals as well as societies building a dynamic cultural memory. Such reflection does not provide a sufficient reason for doing the good, just because any linguistic utterance would be insufficient without the experience of the call itself. A theory can only point to such call without being able to give a

foundation, which would negate the phenomenon of the call as originating such utterance.

Our being-in-the-world is the 'first call' or primum movens of our will. This might provide a universal non-metaphysical frame of reference for different experiences and ethical theories. Buddhism, for instance, experiences the world in all its transitoriness in a mood of sadness and happiness being also deeply moved by suffering. This mood grasps the world in a specific way. There is something common to all human beings in the basic moods but at the same time there are specific moods at the beginning of human cultures, such as astonishment ("thaumazein") in the Greek experience of the world. Karl Baier points to the danger of building stereotypes particularly when dealing with the differences between East and West with regard, for instance, to the search for harmony as an apparently typical and unique mood of Asian cultures or the opposition between collectivity and individuality (Baier 2006). As there are no absolute differences between cultures there are also no exclusive moods. Experiences such as nausea, pangs of moral conscience or the 'great doubt' are common to Japanese Buddhism and modern Western nihilism. A future intercultural philosophy should look for textual basis from literature, art, religion and everyday culture paying attention to complex phenomena and to the interaction between moods and understanding. If there is a danger of building stereotypes, there is also one of overlooking not only concrete or ontic but also structural or ontological differences by claiming a single world culture that mostly reflects the interests and global life style of a small portion of humanity.

2.2 On the Foundation of IIE

a) Charles Ess' "global information ethics" seeks to avoid imperialistic homogenization while simultaneously preserving the irreducible differences between cultures and peoples (Ess 2006). He analyzes the connections of such an ethical pluralism between contemporary Western ethics and Confucian thought.

Both traditions invoke notions of resonance and harmony to articulate pluralistic structures of connection alongside irreducible differences. Ess explores such a *pros hen* ("towards one") pluralism in Eastern and Western conceptions of privacy and data privacy protection. This kind of pluralism is the opposite to a purely *modus vivendi* pluralism that leaves tensions and conflicts unresolved and giving thus rise to a cycle of violence. Another more robust form of pluralism presupposes a shared set of ethical norms and standards but without overcoming deeply contradictions. An even stronger form of pluralism does not search identity but only some kind of coherence or, as Ess suggests, complementarity between two irreducible different entities.

There are pitfalls of prima facie convergences, analogies and family resemblances that may be oversimplified by a *pros hen* strategy. In many cases we should try to dig into deeper layers in order to understand where these claims originate or simply accept the limits of human theoretical reason by celebrating the richness of human experience. As Kei Hiruta rightly stresses (Hiruta 2006), it is not clear what the points of shared ethical agreements are and how this call for unity fits with a call for diversity concerning the judgements of such ethical perspectives. According to Hiruta, the advocates of ethical pluralism would like to avoid the untolerable, such as child pornography in the Internet, working on the basis of a pragmatic problem-solving strategy leading to "points of agreement" or "responses" on the basis of Socratic dialogue. Socratic dialogue is based on the spirit of *parrhesia* or "direct speech" which is a key feature of Western philosophy (Capurro 2006a).

b) Toru Nishigaki. In his contribution on information ethics in Japan, Toru Nishigaki makes a difference between the search of ethical norms in the context of new information technologies on the one hand, and the changes "on our views of human beings and society" becoming "necessary to accompany the emergence of the information society" on the other hand (Nishigaki 2006, 237). Such changes

concern, for instance, the Western idea of a "coherent self" being questioned by information processing in robots. While this change may lead from a Western perspective to nihilism, Buddhist philosophy teaches that there is no such a thing as a "coherent self" ethics having to do with compassion as well as with the relationship between the individual and the community. The key ethical question might be how our communities are changing instead of how far the "self" is endangered. As Nishigaki remarks: "It is possible to say, therefore, that in a sense the West now stands in need of Eastern ethics, while the East stands in need of Western ethics" (Nishigaki 2006, 238). Nishigaki stresses at the same time, that there is no "easy bridge" between IT and Eastern philosophy. IT as looked from a cultural standpoint "has a strong affinity with the Judeo-Christian pursuit for a universal interpretation of sacred texts."

While we in the West look for some kind of unchanged meaning of terms, such as in Charles Ess' pros hen search for shared values and a tolerant or benevolent view on judgment diversity, the ZEN master is eager to exercise himself in his disciple "by doing away with universal or conventional interpretations of the meanings of words" (Nishigaki 2006, 238). In other words, the Buddhist stance teaches us, Westerners, another strategy beyond the controversy between monism and pluralism, by way of a different kind of practice than the Socratic dialogue. Nishigaki points to the controversy in the West between cognitive science and its view of cognition as a "representation" of the "outer world" and the view shared by our everyday experience as well as, for instance, phenomenology. Biologist Francisco Varela's theory of autopoiesis offers an alternative based on the Buddhist view on cognition as "a history of actions performed by a subject in the world" being then not representation of a pregiven world by a pregiven mind but "enactment" of such a history in the world.

c) Terrell Ward Bynum. 'The' information society is and has always been culturally fragmented into different information societies. Consequently, what is morally good for one information society may be considered as less appropriate in another one. Terrell Ward Bynum advocates, borrowing insights from Aristotle, Norbert Wiener, and James Moor, for a "flourishing ethics" which means that "the overall purpose of a human life is to flourish as a person" according to the basic principles of freedom, equality and benevolence and the principle of minimum infringement of freedom (Bynum 2006). If the goal is to maximize the opportunities of all humans to exercise their autonomy – a conception of human existence that is culturally grounded in Western social philosophy – Bynum rightly follows that "many different cultures, with a wide diversity of customs, religions, languages and practices, can provide a conductive context for human flourishing" (Bynum 2006, 163). In other words, Wiener's principles provide a foundation for a non-relativistic global ethics that is friendly to cultural diversity. Bynum widens the scope of this human-centered ethics into a "general theory of Flourishing Ethics" which includes the question of delegation of responsibility to 'artificial agents' and the consequent need for ethical rules for such agents. Although Bynum welcomes different ethical traditions, he is well aware that some of them would not be compatible with "General Flourishing Ethics".

d) Bernd Frohmann. Following Michel Foucault and Gilles Deleuze, Bernd Frohmann proposes a philosophical interrogation of the local effects of the Internet through three main concepts, namely effect, locality, and ethics (Frohmann 2007). He discusses the relationships between the global and the local or, more specifically, between the flows of capital, information, technology, and organizational interaction by pointing to the similarities and difference of today's "space of flow" (Manuel Castells) with some of its predecessors for instance in England's global empire. According to Frohmann, "ethical action consists in a 'mode of subjectivation' not eclipsed by the will to truth's drive to knowledge, transcendence, and universality. A philosophical ethos seeks contingencies and singularities rather than universal determinants, which block the aim of getting 'free of oneself'" (Frohmann 2007, 64-65). This is a plea for a kind of Intercultural Information Ethics that focuses on a careful situational analysis starting with the local conditions which does not mean monocultural chauvinism but critical appraisal of the way(s) computers control societies and the strategies people can develop in order to becoming "digitally imperceptible." Frohmann asks for strategies of "escaping" the Internet rather than "localizing" it as far as it can become a local instrument of oppression.

e) Luciano Floridi. Distinguishing between "ethics of global communication" and "global information ethics", Luciano Floridi addresses respectively: on the one hand, the pragmatic dialog in the interaction between different cultures and generations, on the other hand, the foundational questions regarding the possibility of common principles allowing such dialog, or the existence of a macro-ethic in the sense of some kind of consesualism or deontologismo or contractualism (Floridi 2009: 222).

A key issue in Floridi's theory is the "shared ontology" as a mean to overcome in global information concerns Wittgenstein's problem of the lion: "if a lion could talk, we wouldn't be able to understand it" (Wittgenstein 1953, §568). As a basis for common understanding Floridi proposes a basic ontology of life and death, food and shelter, anguish and protection (Floridi 2009, 224), i.e. whatever allows us to support life and avoid suffering or destruction of any entity, since – based on the very fact of being - every entity has a right for being. The most elemental opposition is *being* vs *entropy*, or the "flourishing of entities" in their global environment vs the "destruction", "corruption" or "impoverishment of being" (Floridi 2008). He names this minimal ontology "ontocentric" –aparently more radical than, for instance, biocentric or anthropocentric. In the center, we find the patient of an

action instead of the agent. He opposes both a metaphysical theory stating something about the being of entities –as a kind of ontological imperialism- and a plain relativism unable to suggest any effective interaction regarding intercultural problems. Without imposing hierarchies of common values, "global information ethics" should allow them to embed them within particular situation and natures ("embeddedness" and "embodiement"). This light and horizontal ontology aims at bridging cultures, which in their vertical and thick density are often irreconcilable.

However, we might ask: this "light" and "horizontal" approach is enough to face the pragmatic problems arisen in intercultural interaction or we also need a thick and vertical analysis to overcome them? How could this minimal ontology be politically accepted? The "dignity of being" does not pose a minimal metaphysical ontology?

f) Philip Brey. For the Netherlander philosopher Philip Brey, an ethical dialog thoughtfully considering cultural differences is necessary to cope with intercultural information ethical problems (Brey 2007). He includes in information ethics issues related to ICTs, computation and mass media, distinguishing between a moral descriptive relativism and a normative level, named meta-ethical. The latter faces the question about the existence of universal values and principles or the cultural relativity of IE, but the problems should be first reflected in a descriptive relativity for afterwards searching for differences and commonalities. He analyses relativism in privacy, intellectual property rights, information freedom and the difference between moralities centered in human rights in Western societies and centered in virtues in Far-east societies influenced by Buddhism, Confucianism, Taoism and Maoism superimposing social harmony to individual welfare.

He leaves to social science the question of the usage of ICT as instruments of oppression or freedom, just focusing on the comparative analysis of moral systems. This limitation

might be a lack to overcome some avoidable cultural relativism, since some cultural closures might have arisen within the tensions regarding oppression and freedom, which can easily be connected to the "suffering" vs "flourishing" –posed, as seen before, as a basis of mutual understanding-. In clear opposition to Brey's stance, the The North American philosopher **Ken Himma** argues for an objectivist moral, which should be comparative and a part of social sciences (Himma 2008). The endeavor of EII is not just interaction –as in Brey- but agreement. However, although he provides good arguments to defend objectivism, he does not develop a system of objective norms for information ethics.

g) Rafael Capurro. In today's information society we form ourselves and our selves mainly through digital media. The power of digital networks does not lead necessarily to slavery and oppression but also to reciprocity and mutual obligation. Globalisation gives rise to the question of what does locally matter. Cyberspace vanishes into the diversity of complex real/virtual space-time connections of all kinds which are not any more separable from everyday life and its materiality. The boundaries of language against which we are driven appear now as the boundaries of digital networks which not only pervade but accelerate all relationships between humans as well as between all kinds of natural phenomena and artificial things.

Following Michael Walzer (1994) and Soraj Hongladarom (2001), Capurro conceives moral arguments as "thick" or "thin" regarding whether they are contextualized or not but questioning the view that there is no third alternative between mono- and meta-cultural ethical claims (Capurro 2007). A purely metacultural information ethics remains abstract if it is not inter-culturally reflected. The task of Intercultural Information Ethics is to intertwin "thick" and "think" ethical arguments in the information field. The analysis by Michel Foucault on the Western tradition of parrhesia or 'direct speech' shows that it as a special trait of Western moral behaviour and democratic

practice in contrast to the importance of 'indirect speech' in Eastern traditions (Foucault 1983). We should develop this difference for instance with regard to Confucian and Daoist thought and their relevance for the development of information societies in Asia. In resonance to Charles Ess' concept of an ethical *pros hen* ("towards one") that looks for a pluralist interpretation and application of shared ethical norms (Ess 2006), Capurro argues in favor of a *hothen* ("from which") approach that turns the attention to the question of the source(s) of ethical norms including the multiple cognitive-emotional experience of such source(s). The task of IIE is not only to describe them, but to open the endless task of translation between them (→*hermeneutics*). As Susan Sontag suggests (Sontag 2004), the task of the translator can be seen as an ethical task if we conceive it as the experience of the otherness of other languages that moves us to transform our mother tongue – including the terminologies used by different philosophic schools – instead of just preserving it from foreign or heretic influences.

The concrete impact of information and communication technologies on different cultures and particularly on their moral foundations has been discussed elsewhere (Capurro 2009, 2010)

3. Debate on IIE. IIE is an emerging discipline. The present debate shows a variety of foundational perspectives as well as a preference for the narrow view that focuses IIE on ICT (Capurro 2008, 2009). Consequently comparative studies with other media and epochs are mostly not being considered so far. With regard to IIE issues in today's information societies, there are a lot of cultures and regions that have not been analyzed so far. Privacy as well as online communities, governance, gender issues, mobile phones, health care, and, last but not least, the digital divide are on the agenda. New issues such as blogs, wikis and "Second Life" are arising. We have to deepen the foundational debate on the sources of morality. According to Michel Fou-

cault, ethics can be understood as the "problematization" of morality. Intercultural Information Ethics has a critical task to achieve when it compares information moralities. This concerns the ontological or structural as well as the ontic or empirical levels of analysis. One important issue in this regard is the question of the universality of values vs. the locality of cultures and vice versa which is related to the problem of their homogenization or hybridization.

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(RC –ed.-; RC, JMD)

K

KNOWLEDGE (S. *conocimiento*, F. *connais-sances*, G. *erkenntniss*, *Wissen*) [transdiscipinary, philosophy, epistemology, cognitive science, semantic] concept

Contents.— 1) Classical epistemologic model, 2) Dretske's informational model, 3) Floridi's semantic model, 4) Systemic model of the UTI, 5) Conductual model, 6) Knowledge and near concepts, (a. Knowledge vs. information, b. Knowledge and mental states, c. Knowledge vs. experience, truth, belief and values).

Throughout the history of thought countless words have been written concerning what knowledge is. There are innumerous proposals, from different philosophical precepts, that have attempted to answer this question. In this sense, if we review the literature on Cognitive Science and epistemology, we can figure out that there are several theoretical models that can meet the goal of offering an adequete definition of knowledge.

1. Classical epistemologic model. The proposal of classical epistemology advocates a definition of knowledge from the notions of belief, truth value and justification (or argument). In this sense, a person A knows that P if and only if it fulfills the following three conditions: (a) A believes that P, (b) P is true and (c) is justified in believing that P.

At the first glance, the classical epistemological proposal provides a solid base to approach the identification process and knowledge representation in the context of an organization. In this sense, in order to conclude that a person knows a concrete thing (has a concrete knowledge), we only have to verify that this person has a belief; the belief that coincides with this supposed knowledge we attribute to

him, that what he thinks is true and that this person is justified in believing in it (that this attributed belief has to be reasoned, not arbitrary).

2. Dretske's informational model. Fred Dretske, the American philosopher, introduced Knowledge in informational terms in 1981. He provides, from his definition of informative content, a definition of knowledge in informative terms: K knows that s is F and only if K's belief that s is F is caused (or is causally sustained) by the information that s is F.

Within this definition must be understood the terms "belief caused by information" as that belief caused by the information contained in the fact that s is F.

In short, restoring the definition of informative content, so that K knows something, K should have information of that something with probability equal to 1, therefore, knowing that s is F requires not only certain information about s (an appropriate or sufficient quantity), but the information that s is F.

Two important theoretical benefits can be drawn from this Dreskian proposal on knowledge:

The first of these benefits is found in the fact that this definition allows us to explain the possibility of transmission of knowledge: when a speaker K knows that s is F and, among other things, ii sincerely asserts that s is F, the listeners will come to know that s is F from what the speaker says (respecting the principle of the introduced copy in the previous section). This communicative fact is met, according to Drestkian definition of

knowledge, if K knows that s is F from the information that s is F, and if the transmission of this information is done with an ambiguity equal to 0.

The second benefit is something beyond the possibility of transmission of knowledge. What this definition mainly pursues is to reach the goal of distancing from those clasical epistemological theories that had presented knowledge as a justified and true belief. Dretske replaces the necessity for the justification of belief with causality of information. He seeks, in making such a change, to overcome the problems usually presented by these classical theories (the paradoxes of Gettier and lottery), and also gets an adequate argument against the radical scepticism thesis.

Dretske defends himself from the thesis of radical skepticism (that supports the impossibility of knowledge) clearly distinguishing the conditions of an information source from what is called the conditions of an information channel. While a source generates information, the conditions of a channel, although it is crucial for the transmission of information, do not affect the information circulating within it. In this respect, the communication channel should be considered as a series of conditions which the sign depends on, that either does not generate (relevant) information, or only generates redundant information. In short, the channel offers no relevant alternatives to the source, and what makes an information channel to be ambiguous is its charateristics, not the suspicions that may or may not circulate information within it.

3. Floridi's semantic model. According to Floridi´s semantic approach (2005a, 2005b), knowledge is constituted in terms of justifiable semantic information, i.e. information constitutes the elements for further inquiry. At the same time, information is the result of a data modelling process. But unlike Dretske's naturalistic assumption, this data modelling does not necessarily represent the intrinsic nature

of the studied system, or it must not be directly related to the system by means of a causal chain; instead, it will depend on the processing of data by knowledge. In turn, data are conceived as the resources and restrictions allowing the construction of information. Therefore, it can be stated that Floridi proposes an architectural relationship between knowledge, information and data, being knowledge on the summit and data on the base. At the same time and as a result of such interrelationship, he replaces Dretske's requirement of truth of (which is also subscribed by the situation theory) by a requirement of truthfulness, i.e. instead of searching for a correspondence between the statement and what the information is about, the attention is rather paid in the correspondence between what is reported and the informer.

4. Systemic model of the Unified Theory of Information (UTI). From a detailed approach to system theory considering different self-organization levels (from self-restructuring to self-re-creation), knowledge is constituted in the →*UTI* by means of interpreting data (or meaning assignment) and is the basis for decision-making, which shapes "practical wisdom" (Hofkirchner 1999).

UTI refers to different levels of information rather than dependency relationships, i.e. information is gradually processed: first, at the syntactic or structural level there is data, then at the semantic or state level there is knowledge, and, finally, at the pragmatic or behavioural level there is practical wisdom. The information processing is performed by means of interrelationship and reciprocal action between adjacent strata and not in terms of a casual progression (as in Dretske's naturalism). In other terms, between micro- and macro-leves there are upwards- and downwards causations (regarded as information processes) cooperating in the self-organizing processes.

5. Conductual model. For example, it is argued that, relating to the conduct and actions

of an agent, knowledge is the potential capacity that an actor poses to act effectively. The effectiveness means to compare the behavior and potential outcomes with the objectives and values of both the actor and those of his community or the communities that he belongs to.

Within this conceptual framework one argues that there are various types of knowledge. The first one is the knowledge of internal information. In this type of knowledge is the potential capacity of answering questions with correct answers; usually, the questions on real objectives, about the state of one part of the world in some time. For this kind of knowledge, it is a precondition that the actor answers without resorting to any external sources of information. Typically, any answers can be registered in records, which can be used by other actors.

The second type of knowledge is knowledge of external information. This is like the previous one with the exception that in this case the access to other sources of information is permitted.

In the third place, thinking is also a way of effective action. In this case, starting from available information, a process of creating new information takes place, which may become the answer to new questions or the spontaneous production of information by a thinking agent.

Finally, there is a non-informative knowledge; the capacity of effective action is not related to information. It is something that one usually sees in artists and athletes. They can have a highly effective conduct most of the time, but they are unable to explain or articulate their knowledge on recorded information.

6. Knowledge and near concepts

a) Knowledge vs. information. From most points of view regarding information and knowledge, there are close relationships between these two concepts, especially as far as the common use of both terms is concerned. Usually, information occupies a lower position than knowledge, and the former —so to speak-

'nourish' the latter. However, this connection is disregarded in cases of a radical syntactic approach, in which the relationship question is avoided just addressing to the technical dimension (as in the MTC), or in a radical pragmatic approach in which only what-is-being-done is posed, that is, information is considered as a mere instrument of the action and, therefore, the problem of whether the information refers to states of affairs is ignored (either dealing with a correct apprehension or knowing that p is the case).

Although there have been throughout the history of thought countless approaches to knowledge concerning its definition, possibility, basis and modes, two fundamental models have prevailed: 1) the iconic model, according to which knowledge is an accurate picture (of mental nature) of the object of knowledge, and 2) the propositional model, whereby knowledge is a truthful proposition. In the iconic model, where perception and apprehension play a key role, the main problems lie in both the specification of the limits between object and subject, and the explanation of non-iconic knowledge (such as logical, mathematical and logical "truths"). However, in the propositional model, where scientific statements play an exemplary role, the unavoidable circle of the justification of knowledge becomes problematic (→*Gödel's incompleteness theorem*). Nevertheless, whatever the model of representation, knowledge is distinguished from a true opinion, insofar as only the former knows how to justify itself (though its justification might be partial or problematic).

According to the above, the relationship between information and knowledge must evidently appear in all those informational approaches considering the semantic dimension, usually adopting a more analytic notion with respect to information, and a more synthetic one with respect to knowledge. Furthermore, a closer proximity to the object is used in information concerns, and to the subject in knowledge concerns.

For Dretske -as mentioned above-, "Knowledge is information-produced belief" (Dretske 1981, 91-92) and belief always relates to "a receiver's background knowledge" (pp. 80-81). From a naturalistic perspective, in which there is a casual dependence between the external conditions of a living being and and its internal states, information for Dretske creates experience (sensorial representations) and originates beliefs (cognitive experiences), which underlie the sedimentation of knowledge.

b) Knowledge and mental states. We can agree, leaving aside the existing alternative definitions, that knowledge must be identified with a special kind of mental states (neuronal arrangements), presenting a set of particular characteristics, which an individual possesses. On the one hand, they are mental states achieved by the individual from a process of information assimilation or metabolism. This characteristic helps to distinguish those mental states of the subject corresponding to knowledge from those corresponding to mere beliefs, which do not reach the necessary epistemic level to be identified as knowledge.

In this sense, the semantic content of those mental states coincides with this assimilated information. And the mental states, conversely, act as a guide for actions and conduct of that individual; in other words, they control the decisions made by the subject.

We can reflect this characterization in the following synthetic expresion: Knowledge = the mental states of an individual constructed from the assimilation of information, which steer the actions performed by the subject.

However, the characteristics of knowledge do not end here. We can elaborate a little more about this special kind of mental states. Knowledge, unlike data and information, is closely related to the actions and decisions of the subject, we can even evaluate this knowledge using as indicators such actions and decisions. Moreover, knowledge is the critical factor that permits the holder to assimilate new information -therefore, the creation

of new knowledge-; and often it is continuously restructured by the entries of new assimilated information.

c) Knowledge vs. experience, truth, belief and values. Nonetheless, it is not sufficient to provide a definition of knowledge and explain it with a couple of examples to have a better understaning of it. It is also necessary to deal with a number of related and interrelated concepts.

In this vein, we should not forget a concept very close to knowledge, and which partly allows its acquisition: experience. Experience can be defined as the set of living-experiences that each individual has been through. And as such, it makes possible the creation of new knowledge through enabling the understanding of new situations from others that have been experienced, and to find new answers allowing us to adapt to new scenarios.

We should neither forget the concept of truth. As it has been defended since Classical Greece, knowledge (or at least a special type of knowledge, as we wil see) implies truth: if A (an individual) knows P, then it is true that P. If anyone knows that the water molecule consists of two hydrogen and one oxygen atoms, then it is true that this molecule presents the arrangement of atoms. And it is knowledge and its arising actions that have to be in tune with what really happens. Reality deals with refining and improving knowledge, rejecting and cleaning our heads from this supposed knowledge (pseudo-knowledge) that does not work and is not attuned.

Another closely related concept is belief, understood as the mental state that an individual possesses. Because knowledge (or at least one type of knowledge), besides truth, implies judgement or belief: in order that someone knows P, this someone has to believe that P. That is, knowledge must maintain a commitment to the truth of P. If someone knows that the water molecule consists of two atoms of hydrogen and one of oxygen, then that someone must believe that this molecule presents the arrangement of atoms.

And finally, when we are talking about knowledge, we can not avoid the realm of values. Values determine the background that governs our actions and therefore our way of knowing and our knowledge.

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(MPM –ed.-; MPM, JMD, RG)

KNOWLEDGE MANAGEMENT (S. gestión del conocimiento, F. Gestion des connaissances,

G. Wissensmanagement [business management, ICT, Information Society] discipline

In the last decade, a strong movement concerning a new discipline has emerged and developed, focused on the scope of organizations: Knowledge Management. This discipline deals with designing systems and strategies to systematically use the knowledge involved in an organization. Applying the concept of Knowledge Management to the context of companies has been an important source of competitive advantage that can ensure the proper functioning and survival of the companies in the present economic scenario characterized by tough competition and market globalization.

It is not easy to define Knowledge Management. There is no agreed or shared definition among the entire scientific community (Nonaka and Takeuchi, 1995; Davenport and Prusack, 1998; Boisot, 1998; Sveiby, 2001, Wilson 2002).

As a starting point, it should be clarified that it is not easy to speak of Knowledge Management in the abstract. Strictly speaking, only in the context of an organization does it make sense to deal with Knowledge Management.

In a broader sense, each organization is a community or a group of individuals whose members are structured and framed to meet some certain targets. The paradigm of an organization is usually a company (firm), but with this description one can consider other communities of individuals as organizations (not with such financial targets), communities such as a hospital, an NGO, an educative center, a ministry, a research center or a political party.

Given this, Knowledge Management, in an intuitive sense, deals with designing and implementing systems whose goal is to identify, capture and share systematically the involved knowledge in an organization in such a way that it can be converted into a value for the organization. Knowledge, in this context, is all the information assimilated by a subject and oriented toward action. In other words,

knowledge is any mental state of a subject (in short, a concrete neuronal provision) that has been caused by a determined information and which allows the subject in question to make certain adequate decisions and carry out practical action derived from the decisions (Audi, 1988; Crayling, 1998). On the other hand, knowledge becomes a value to an organization when it has a clear contribution in achieving the goals of the organization.

It is possible to enrich and make more operational and functional this first intuitive definition of Knowledge Management if we keep in our mind the existence of different types of knowledge within an organization, and that, therefore, it is essential to respect the special nature of each in order to design the most appropriate management.

In this sense, it is possible to distinguish 6 types of knowledge within an organization. These 6 types can be grouped together in the following three pairs:

a) Tacit Knowledge / Explicit Knowledge

b) Individual Knowledge / Organizational or Corporate Knowledge

c) Internal Knowledge / External Knowledge

Let us begin with the first pair. Tacit knowledge is the knowledge that is based on personal experience and in many cases is identified with the skills of the subject. Its main feature is that it is hardly transmissible or communicable; therefore, it is not accessible to the other individuals in a direct way. To show that someone, A, has knowledge of this type, we normally use the expression "A knows P" (where P is usually a verb). In the same way, there are several examples of such knowledge: knowing how to swim, knowing to ride a bicycle, knowing to drive a car, knowing to speak in public or to articulate and lead a group of people.

Explicit knowledge, in contrast, is characterized by being directly encoded in a representation system such as natural language. Thus, it is easily transmitted or communicated and it is accessible to other individuals directly. To show that someone, A, has knowledge of this type we usually use the expression "A knows that P" (where P is usually a statement). Therefore, knowing that water is H2O or knowing that when the photocopying machine has the red light on someone should change the cartridge are two examples of this type of knowledge.

Let us go to the second group of knowledge. For individual knowledge we can understand all knowledge which an individual of an organization possesses. Therefore, the individual knowledge of a person consists of all explicit and tacit knowledge possessed by this member. Individual skills, personal contacts and relationships or technical knowledge that a person posseses can be identified as a part of the individual knowledge that he has.

Conversely, corporate or organizational knowledge is the knowledge that can be attributed to an organization, the owner of the organization. This knowledge is usually physically presented in some kind of document. The databases purchased by an organization or intellectual property and patents that they develop are two clear examples of this type of knowledge.

Finally we have the third last group. The internal knowledge is that knowledge which is critical for the appropriate functioning of an organization. In other words: the knowledge without which it would be impossible for the organization to operate. If we identify a chemical laboratory as an organization, the knowledge possessed by the chemists of this laboratory or the patents developed by them are two good examples of internal knowledge of the organization.

External knowledge, however, is that knowledge that an organization uses to interact with other organizations. The knowledge in the published reports of the organization or on its external website are examples of this last type of knowledge.

With the definition of these six types of knowledge in hand we can propose a much more complex second definition of Knowledge Management in organizations.

In this sense, Knowledge Management within an organization may be understood as the discipline that deals with designing and implementing a system whose main objective is that all tacit, explicit, individual, internal and external knowledge involved in the organization can be converted systematically to an organizational or corporative knowledge, in such a way that the corporate knowledge, being accessible and shared, allows the increase in the individual knowledge of all its members and improves the contribution of these individuals in achieving the goals of their organization directly.

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(MPM. –ed.-; MPM., MG)

KNOWLEDGE ORGANIZATION (S. *organización del conocimiento*, F. *organisation de la connaissances*, G. *WissensOrganisation* [LIS, information society, knowledge management] discipline

Knowledge Organization (KO) is a field of study that comprises techniques to organize documents, concepts, and relationships among them. One of the tasks that KO carries out is to increase the interoperability mechanisms to enable a way to employ these techniques in a worldwide media. Related fields are

information classification, information retrieval, information visualization, and knowledge acquisition, amongst others.

It should not be confused with knowledge management (KM), since the latter is focused on the field of organizations, whereas KO has a more general orientation, less focused on the concrete returns of organizations, which objectives are more concrete and explicit. Nevertheless, KM is supported by KO as one of its basic processes and techniques.

A great number of methods to organize knowledge are based on principles stated by librarians. Some librarian resources used in KO are controlled vocabularies and classification schemes (v. indexing language, thesaurus, and taxonomy).

Fields related are often overlapped, some of these fields and the resources that they develop are:

Linguistics: NLP tools like taggers, stemmers, terminological and lexical databases, etc.

Artificial Intelligence: ontologies, neural networks, and reasoning engines.

Statistics and data mining: classifier and clustering algorithms.

Information Extraction and Retrieval: named entities recognition and classification, correference resolution, etc.

Librarian and information science: resources controlled vocabularies and classification schemes, indexing techniques, metadata vocabularies.

Computer science: design applications to organize and retrieve.

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(SSC. –ed.-; SSC, JML)

KNOWLEDGE ORGANIZATION SYSTEM (S. *sistemanas de organización del conocimiento*, F. *Systèmes de organisation de la connaissances*, G. *WissensOrganisation Systeme* [information science] concpet

The concept Knowledge Organization System (aka KOS) group different classification schemes used to organize knowledge. Some KOSs are library classifications, taxonomies, subject headings, thesauri, ontologies, etc. KOS is a corner stone in Knowledge Organization tools.

Knowledge Organization techniques are used to build KOSs. These techniques outline principles to build, manage, and visualize KOS. Knowledge Organization Systems show a simplified view of the concepts of a domain. The goal is provide a way to improve the understanding and the management of a field of knowledge.

On account of the variety of disciplines needs to facilitate their understanding, KO Systems are present in a wide range of fields of knowledge. There are examples of KOS in e-learning, Artificial Intelligence, Software Engineering, and Information Science. Each of these fields gives to KO Systems one or more different names, and design these KOS in a different way, according its specific goals. In this manner, e-learning talks about mind maps and concept maps; Artificial Intelligence address ontologies and semantic networks; Software Engineering talks about UML diagrams; and Information Science use thesauri, subject headings, library classifications, etc. Although, each approach has different semantic structures depending on its goals, all of them collect a domain vocabulary to represent concepts, and semantic relationships among these concepts.

The construction of a KOS requires a high intellectual effort to reach an agreement about the representation. This implies to analyze the domain to extract the main concepts and relationships and to agree these analyses in order to show a shared representation. This is a laborious and exhausting work with frequent

delays. These problems might be minimized with a systematic methodology to develop these models. Examples came from Software Engineering and Ontology Engineering. Several software applications have been implemented to easy these tasks.

One of the main bottlenecks is knowledge acquisition. This phase tries to identify the main concepts, by different information sources and experts. Next step, it is conceptualization, that is structure the domain. This implies analyze terminology, synonyms, hierarchical, and associative structures. Besides these structures it is important to identify the constraints that present each relation or attribute.

Some approaches have been made to group different KOSs. In this regard and from the ontology engineering point of view, thesauri and other library classification are called light ontologies, in contrast to true ontologies (Daconta et al., 2003; 157; Lassila, O. y McGuinness, D. L., 2001; Gruninger y Uschold, 2002).

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KOLMOGOROV COMPLEXITY (S. *Complejidad de Kolmogorov,* F. *Complexité de Kolmogorov,* G. *Kolmogorow-Komplexität*) [AIT, computer science, complexity theory, coding theory] concept

Contents.— *1) Absolute and relative complexity measures; 2) Complexity with respect to an algorithm; 3) Absolute Kolmogorov complexity; 4) Diversity of naming, approaches and applications.*

1. Absolute and relative complexity measures. Kolmogorov complexity is an algorithmic measure or measure of algorithmic information. It is defined for constructive objects, such as words in some alphabet. If x is a word, then the original *Kolmogorov complexity* $C(x)$ of a word x (also denoted by $K(x)$) is taken to be equal to:

> the size of the shortest program (in number of symbols) for a universal Turing machine U that without additional data, computes the string x and terminates.

As Turing machines are recursive algorithms, the original Kolmogorov complexity $C(x)$ is a *recursive* complexity measure.

This measure is called *absolute Kolmogorov complexity* because Kolmogorov complexity has also a relative form $C(x \mid y)$. Namely, the *relative Kolmogorov complexity* $C(x \mid y)$ of the word x relative to the word y is taken to be equal to:

the size of the shortest program (in number of symbols) for a universal Turing machine U that with y as its input, computes the string x and terminates.

The relative Kolmogorov complexity $C(x \mid y)$ allows one to find the algorithmic quantity $I(y ; x)$ of *information in a word y about a word x.* Namely, we have

$$I(y ; x) = C(x) - C(x \mid y)$$

2. Complexity with respect to an algorithm. The Kolmogorov complexity $C_A(x)$ of an object (word) x with respect to an algorithm A is defined as

$$C_A(x) = \min \{l(p); \ A(p) = x\}$$

in the case when there is a word p such that $A(p) = x$;

otherwise $C_A(x)$ is not defined.

If the *Church-Turing Thesis* ($\rightarrow$*Turing Halting Theorem*) is accepted, then any algorithm is modeled by a Turing machine and Kolmogorov complexity is considered only for Turing machines.

3. Absolute Kolmogorov complexity. Solomonoff (1964), Kolmogorov (1965), and Chaitin (1969) proved that there is an invariant up to some additive constant Kolmogorov complexity $C(x)$. It is called *absolute Kolmogorov complexity* because there is also *relative Kolmogorov complexity* $C(x|y)$. Namely, there is a Turing machine U such that for any Turing machine T, there is a constant c_{UT} such that for all words x, we have

$$C_U(x) \leq C_T(x) + c_{UT}$$

The machine U is a *universal Turing machine*. This makes the concept of Kolmogorov complexity invariant up to an additive constant if we put $C(x) = C_U(x)$.

However, it is necessary to understand that this invariance is not absolute because the value of the constant c_{UT} depends on the choice of the universal Turing machine U (Weinstein, 2003; Burgin, 2005).

It was demonstrated that Kolmogorov complexity cannot be computed by a Turing machine or by any other recursive algorithm (Kolmogorov, 1965) but can be computed by an inductive Turing machine (Burgin, 1982). When the length of a word tends to infinity, its Kolmogorov complexity also tends to infinity.

4. Diversity of naming, approaches and applications. Although the majority of researchers use *Kolmogorov complexity* as the standard name for this measure, there are authors who prefer a different name. In particular, the following names of this concept are used: *algorithmic information content*, *algorithmic information*, *program-size complexity*, *information content*, *shortest*

program length, *algorithmic randomness*, *stochastic complexity*, *information-theoretic complexity*, *complexity*, *randomness*, *KCS* (Kolmogorov-Chaitin-Solomonoff) *complexity*, *information size*, and *algorithmic entropy*.

Different names reflect different approaches to the concept. When we want to know how difficult it might be computing or constructing some object x with recursive algorithms, *Kolmogorov* or *algorithmic complexity* is an appropriate name. When the question is how much information we need to build or compute x with given algorithms, the name *information size* of x better reflects the situation. When we consider probabilistic aspects of x, e.g., randomness, *algorithmic entropy* might be the best name.

Many versions of Kolmogorov complexity have been introduced. The most known of them are: *uniform complexity* $KR(x)$, *prefix complexity* or *prefix-free complexity* $K(x)$, *monotone complexity* $Km(x)$, *conditional Kolmogorov complexity* $CD(x)$, *time-bounded Kolmogorov complexity* $C^t(x)$, *space-bounded Kolmogorov complexity* $C^s(x)$, and *resource-bounded Kolmogorov complexity* $C^{t,s}(x)$. In addition, Kolmogorov complexity has been extended to infinite processes, infinite words (Chaitin, 1976; 1977), super-recursive algorithms (Burgin, 1995; 2005; Schmidhuber, 2002), quantum computations (Svozil, 1996) and algorithmic problems (Burgin, 2010a).

Existence of different versions of Kolmogorov complexity caused a necessity to build a unified algorithmic information measure. Such a theory has been developed as an $\rightarrow$*axiomatic algorithmic complexity* (Burgin, 1982; 1990; 2005; 2010).

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(MB)

L

LIBRARY SCIENCE (S. *biblioteconomçia*, F. *sciences des bibliothèques, bibliothéconomie*, G. *Biblio-theks-, Dokumentations- wissenschaft* [research, information management] concept

Branch of the information sciences devoted to the theoretical and technical knowledge concerning organization and administration of libraries. It deals with the managing of collections and information resources, and the provision of user access.

At the beginning of the 20th century, the term "information" was frequently linked to *Special Librarianship* in the English speaking world. In the 1960s and after a period in which this activity was associated to Documentation, it converged with what was labelled as *Information Science* (which in some Latin-American countries has been translated into "Ciencia de la Información", with a sense close to the English usage). According to Capurro and Hjørland (2003), this was motivated by: (i) the growing interest in computer applications, (ii) the influence of Shannon's theory, and (iii) the current information processing paradigm in cognitive sciences.

Considering Library Science as academic discipline related to librarians and documentalists, two clear trends have been distinguished: the *general approach*, mainly focused on public libraries with emphasis in general education and significantly detached from the knowledge it serves; and the *specialised approach*, aimed at specific knowledge domains. However, although this second approach was relatively dominant until the 1970s, thereafter it lost its leading position as education tended to become more general and oriented towards

psychology, subjective idealism and methodological individualism. But simultaneously, an intermediate approach emerged which could be branded as a neutral specialisation (even formal or abstract), the *domain-analytic approach*, related to hermeneutics, semiotics and social constructivism (Capurro & Hjørland 2003).

According to Griffith's definition (1980), "Information Science is concerned with the generation, collection, organisation, interpretation, storage, retrieval, dissemination, transformation and use of *information*, with particular emphasis on the applications of modern technologies in these areas". The objective of its disciplinary framework is "to create and structure a body of scientific, technological and system knowledge related to information transfer". Thus –despite the problematic or contingent linkage to used tools made by Griffith– it can be stated that we are dealing with a science which contains elements being *theoretical* (except for its specific application) and *applied* (aimed at services and products).

Regarding the conceptualisation of information carried out in this field, it can be stated that special focus is put on two confronted meanings: 1) the information as an object in documents and 2) its radical subjectivisation, i.e. information as everything "that can be informative to someone".

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(BR –ed.- ; JMD, BR)

M

MATHEMATICAL STRATUM OF THE GTI (S. *Sustrato matemático de la TGI,*, F. *La strate mathématique de la TGI*, G *Die mathematische Substrat der GTI*) [General Theory of Information] theory

The *mathematical stratum* of the →*General Theory of Information (GTI)* builds mathematical models of information, information processes and information processing systems. According to the basic principles of GTI, information is intrinsically related to transformations. That is why portions of information are modeled by information operators in infological system representation spaces or simply in information spaces. Informally, an information space is a space where information functions (acts). In the formalized approach, information spaces are constructed as state or phase spaces of infological systems. It is possible to use different mathematical structures for state/phase representation. Thus, the mathematical stratum of the GTI is build as an operator theory in information spaces based on principles of this theory, which are translated into postulates and axioms.

There are two types of mathematical models of information: (1) information processes and (2) information processing systems. This separation results in two approaches: *functional* and *categorical*.

In the **functional approach**, the information space is represented by functional spaces, such as Hilbert spaces or Banach spaces, while portions of information are modeled by operators in these spaces.

In the **categorical approach**, information spaces are represented by abstract categories

(Burgin 2010b). There are two forms of information dynamics depiction in categories: the categorical and functorial representations. The *categorical representation* of information dynamics preserves internal structures of information spaces associated with infological systems as their state or phase spaces. In it, portions of information are modeled by categorical information operators. The *functorial representation* of information dynamics preserves external structures of information spaces associated with infological systems as their state or phase spaces. In it, portions of information are modeled by functorial information operators.

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(MB)

MENTAL CONTENT (S. *contenido mental*, F. *contenú mentale*, G. *mentaler Inhalt*) [mind, semantics, psicology, cognitive science] concept

It is commonly assumed that mental states can be characterized by a certain psychological attitude and a certain content. The content of a mental state is a mental content. A precedent of that analysis can be found in Russell. Believing, desiring, remembering, feeling, perceiving, etc., are examples of psychological attitudes. What is believed, what is desired, what is remembered, what is felt, what is perceived,

etc., would be the mental content that in each case is associated with those attitudes.

Very often, it is also assumed that there are two big classes of mental contents: conceptual and non-conceptual ones. Conceptual content is the semantic content that we can find in words, expressions and sentences of a language. The content that beliefs, desires, re-memberings, etc., typically have is the same as the content of certain sentences. Mental states with conceptual content are also called "propositional attitudes", their content being a particular proposition that could be expressed by a certain sentence.

Non-conceptual content is an experiential, qualitative or phenomenological content. It is eventually the content that feelings, perceptions and sensations typically have. Whereas conceptual content is semantically evaluable in a quite direct way, non-conceptual content is not so. However, non-conceptual content can be evaluated as more or less correct or incorrect, or as more or less adequate or inadequate, etc. Mental states with non-conceptual content are usually called "qualitative states", "experiential states" or "phenomenal states". Their content would be a qualitative, experiential, or phenomenal character not identifiable with any proposition.

A very important thesis with respect to the distinction between conceptual and non-conceptual content is that perhaps there are mental states with both conceptual content and non-conceptual content. Another not least important thesis is that perhaps every mental state with conceptual content has also some kind of non-conceptual content.

The contrast between internism and externism has given place to one of the more dramatic discussions about mental content in recent years. Internism claims that mental contents – and mental states-- only depend on factors internal to the mind of the subjects. Externism claims that mental contents –and mental states-- essentially depend on factors external to their minds. Those external factors may include linguistic norms of the community, how

experts would use certain terms, and the relationships with the external world. Descartes and Frege are two paradigmatic classical examples of internism. Externism was introduced by authors like Putnam, Burge and Kripke.

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The bibliographic resources offered by David Chalmers in his website are extremely useful:
<http://consc.net/chalmers/>

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(ML)

MESSAGE (S. *mensaje*, F. *message*, G. *Botchaft*, *Nachricht*) [transdiciplinary, communication theory, angeletics] concept

Contents.— *1) Introduction, 2) Message and information, from Shannon's confusion towards a systematic dis-*

*tinction, 3) Analysis of Messages, 4) Fallibility and effi-
ciency of messages, 5) Beyond human contexts: a crossroad
between biology and hermeneutics*

1. Introduction. The message plays such a central role in communication processes that "the Theory of Communication is largely a theory of messages" (Ferrater Mora 1994). However, the common direct association between message and information arises from a confusion –even a conceptual void- which source can be found in Shannon's communication model. For the sake of improving our understanding of both message and information, a clarification is needed in order to address the involved phenomena better.

If communication requires at least a sender, receiver, a medium and a message, but regarding McLuhan famous dictum "the medium is the message", what is then a message? Bringing here some clarity, restoring its importance, is perhaps a way to circumvent the "disangelium of current times" referred by Sloterdijk (1997) or the "phantasmagorical" character of new media evoked by Zizek (1997).

2. Message and information, from Shannon's confusion towards a systematic distinction. Claude Shannon's theory of communication (Shannon 1948) is not a theory about information transmission but about message transmission. Shannon uses the term 'message' instead of 'information' in its usual meaning as 'knowledge communicated'. The concept of information within this theory refers to the number of binary choices in order to create or codify – a message. In reality – as it was conceived and applied – the theory is about signal transmission and the ways in which to make it more reliable. Shannon correlates information and uncertainty, as opposed to the everyday meaning of information. The semantic and pragmatic aspects are excluded from this engineering perspective of communication. Warren Weaver found Shannon's definition of information as counterintuitive (Shannon & Weaver 1972). But Shannon had indeed substituted the everyday meaning by using the word message.

Message and information are related but not identical concepts:

— a message is sender-dependent, i.e. it is based on a heteronomic or asymmetric structure. This is not the case of information: we receive a message, but we ask for information,

— a message is supposed to bring something new and/or relevant to the receiver. This is also the case of information,

— a message can be coded and transmitted through different media or messengers. This is also the case of information,

— a message is an utterance that gives rise to the receiver's selection through a release mechanism or interpretation.

Thus, we observe they are interrelated concepts but clearly not coincident. How might they be distinguished? The theory of social systems provides us here some insights. Following Luhmann, a communication process within a social system is a three dimensional juncture of a meaning offer, selection of meaning and understanding (Luhmann 1987, 196, →*Autopoiesis*). Considering message as meaning offer, and information as its selection, we already have a distinction: *message* ("Mitteilung") is the action of offering something (potentially) meaningful to a social system ("Sinnangebot"); *information* ("Information") is the process of selecting meaning from different possibilities offered by a message; and *understanding* ("Verstehen") is the integration of the selected meaning within the system. Communication melts these differences towards a unity.

Message, as meaning offer is sender dependent, therefore heteronomous. We receive messages, but we look for information, which we can only do if a meaning offer exists. A message brings to the recipient something new or surprising, causing uncertainty. It can be through different means codified and transmitted, arriving to recipients somehow distorted. Finally, the selection of meanings offered by the message always takes place over

the background of a pre-understanding. Recipients understand messages distinguishing between the meanings offered and selected. The Recipient can doubt about the message, interpreting either way or even neglecting it. The heteronomy of the message stands therefore against the autonomy of interpreting.

3. Analysis of Messages. Messages admit an Aristotelian analysis in terms of form, goal, content, producers (and recipients).

Regarding its form, messages can be primarily distinguished between: *imperatives*, *indicatives* and *optionals*. However, from the point of view of the message directivity, two extreme forms can also be identified: 1) a human sender, an individual or a group, may believe to have a message for everybody and for all times, and vice versa, 2) someone may think everything is a message to him/her. Between these two poles there are several possible hierarchies.

The form of the message has a basic constraint related to the effectiveness: in order to select or interpret a message the receiver must have some kind of common pre-understanding with the sender of the message, for instance a similar form or (linguistic) code.

In his theory of communication or "communicology" Vilem Flusser makes a basic distinction concerning two goals of communication:

— the *dialogical* goal, aiming at the creation of new information,

— the *discursive* goal, aiming at the distribution of information (Flusser 1996, →*Dialogic vs. Discursive*).

A third goal related to the preservation of information could be added, namely *conservational*, embracing librarian and archivist activities.

According to Flusser the age of mass media with their hierarchical one-to-many structure of information distributors —we could call this the CNN-principle— would finally dominate all forms of information creation. In other words, the possibility for a receiver to become

a sender of messages within a dialogical system remains a subordinate option. Since the rise of the Internet things started to change, at least concerning the easier and cheaper possibility for many receivers to become senders, including such hierarchical distribution options as one-to-one, one-to-many, many-to-many and many-to-one.

These distribution hierarchies also correspond to *power constellations*, which play a crucial role determining contents, producers and recipients: Who is allowed to send and preserve? What messages can be sent? Which recipients can be addressed? How can it be done (including technical conditions)? What purposes are allowed? Whereas in the antiquity the dissemination of messages was a sign of god and power, with the advent of philosophy the legitimacy of this right came into question. Historically a change from a vertical message structure to a horizontal one can be observed (Capurro 2003a, Díaz & Al Hadithi 2009). The heteronomous determination of messages gives rise to its vertical character; however, philosophical and scientific discourses are examples of how a heteronomous message can be embedded into a horizontal structure, i.e. "dialogical".

Concerning the possibilities and constraints of digital media with respect to power constellation and the resulting verticality or horizontality of communication, there is an ongoing debate on the future structure of the Internet. The pressure of established information oligopoles (= concentration of power in few hands) will not vanish although it may decrease. At the same time new forms of domination and exclusion arise (Capurro et al 2007, →*Critical Theory of Information*, Fuchs 2009).

A thorough analysis of messages (regarding production, transmission and reception) concern different aspects such as origin, purpose, and content of messages, power structures, techniques and means of diffusion, history of messages and messengers, coding and interpreting messages, as well as psychological, po-

litical, economic, aesthetic, ethical and religious aspects. Therefore an interdisciplinary stage, named →*angeletics*, has been postulated where media studies, the study of signs (semiotics) and their interpretation (→*hermeneutics*) are specifically convened.

4. Fallibility and efficiency of messages. What kind of specific criteria can be postulated concerning the way a sender, a medium and a receiver of messages should act in order to be successful under finite conditions? By finite conditions we mean that neither the sender, nor the messenger, nor the receiver have any kind of certainty that their actions will fit the ideal situation in which:

— a sender addresses a receiver, sending him/her a message that is new and relevant for him/her, i.e., he/she follows the principle of respect,

— a messenger brings the message undistorted to the receiver, i.e., he/she follows the principle of faithfulness,

— a receiver reserves judgement, based on a process of interpretation, about whether the message is true or not, i.e., he/she follows the principle of reservation.

In order to achieve the goals pursued in message production (mentioned above), the sender requires a strategy and planning on how messages should be generated, structured and released. The cognitive processes involved in the planning of a message addressed to a certain target may be conscious or unconscious. The main objective of the sender as he intends to send a message is to affect the conduct and/or mental architecture of the receiver. The design of the message may differ depending on which subsidiary goals are pursued (e.g., the desire to be polite), and may also vary depending on the cognitive, rhetorical, social, strategic, etc. capacities of the individuals involved. As a result, several plans are executed simultaneously when a message is produced, transmitted and interpreted.

The different theories on the production of messages generally agree on the idea that partakers are subject to the same kind of cognitive dynamics at the planning of messages.

Regarding the more or less interactive character of communication, which depends on the form and related power constellations mentioned above, the message production can be more or less cooperative. Indeed, the representations produced by the sender do not "inject" a certain meaning in a passive receptor. The simultaneous and interactive character of communication (if it is horizontal as argued above), as well as the constant exchange of roles between sender and receiver, leads to a model where the message is produced as a result of the collaboration of the partakers. The different plans at stake when transmitting and interpreting a message must adapt instantaneously to the speech situation, forcing the agents to adapt their messages to the different constraints of the communicative context.

5. Beyond human contexts: a crossroad between biology and hermeneutics. The concept of message has also been frequently used in non-human contexts, especially in biology (genetics, molecular biology). However, the communication model used above to make a distinction between message and information, as well as the analysis used to get a deeper understanding of messages has to be simplified. Considering the original twofold meaning of the term 'information' as 'moulding matter' and as 'knowledge communicated' we can say that a cell or, more generally, a living system, is in-formed on the basis of *message selection* in order to satisfy its constraints. Moreover, a self-organizing system can be seen as a system able to make a good behavioural selection among the offer of behaviours within the received messages and with respect to its survival (→*autopoiesis*). The dynamics of the selection mechanism has to be understood in a diachronic perspective.

The physicist Carl-Friedrich von Weiszäcker remarks that the modern concept of information is a new way of asking for what Plato

and Aristotle called *idéa* or *morphé* (Weizsäcker 1974). But what is the main difference between Plato's concept of participation (*methexis*) as in-formation and today's view of communication? Answer: the inversion of the relation between time and form. According to today's evolutionary perspective forms evolve within the horizon of time not the other way round (Matsuno 1998). The process of messages interpretation also evolves in time. Understanding means originally the very fact of being able to provide a correct answer to given possibilities (or messages). This capability evolves "in time" from a very elementary way of responding to messages to a more complex way of interpreting messages (Capurro 2003b).

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(RC –ed.-; JMD, RC)

MIND (S. *mente*, F. *esprit*, G. *Geist*) [transdisciplinar, semántica] concept

The notions of mind, psyche, soul, even consciousness, can be considered equivalent. Perceiving, remembering, believing, desiring, reasoning, taking decisions, imagining, understanding, having emotions and feelings, etc., are examples of mental states and processes. The scientific discipline directly concerned with the mind is psychology, and the philosophical discipline concerned with the mind is the philosophy of mind. There is, however, an area of knowledge interested in mind more generally –both human and animal, natural and artificial, etc.—and in a very interdisciplinary sense. That area is known as "cognitive sciences", or as "cognitive science" in a more ambitious interpretation. Artificial intelligence would belong to that area. Moreover, it has been argued many times that the philosophy of mind would also belong to it.

Very often, mind is contrasted with the physical world and with the external world. Mind seems to constitute some kind of non-physical internal world. In relation with that contrast, the notion of mind involves three important problems: 1) a serious problem of localization (Where is the mind located?), 2) a serious problem of connection (How does the mind connect with the physical world and with the external world?), and 3) a serious problem of epistemic access (How can we come to know something about our own mind? How can we come to know something about other minds?).

There are three crucial aspects of the mind: *intentionality, qualitative character* and *personal identity. Intentionality* is what makes possible that the mind is related with objects and states of actual or possible affairs. Intentionality is exhibited in propositional attitudes, mental

states –beliefs, desires, memories, etc.- with a semantic content able to represent objects and states of affairs. *Qualitative character* is a peculiar quality or phenomenological feature. It is manifest in mental states with a content full of experiential ingredients. Finally, *personal identity* makes reference to our enduring existence as persons with a "self", or an "ego". The three aspects entail very hard problems, both scientific and philosophical.

We need to make reference to another field of problems. The mind can be considered: a substance, a set of properties or attributes, or the result of quite a peculiar sort of description. The realistic compromises of the first option are stronger that those of the second option, and these ones are stronger than those of the third one. The first option is the one of Platon and Descartes, a dualism of substances –the mind as a different substance than the physical, material or extensive substance. The second option is maintained by Aristotle and by many contemporary authors. The third option is favoured by eliminativism. According to *eliminativism*, the mind would not have an objective reality with independence of a certain way of describing and interpreting some sorts of phenomena, including here a certain way of describing and interpreting some phenomena having to do with our own body and our behaviour.

The last point worthy of mention is that perhaps we would not have to speak of "the mind" in general, but of different "kinds of minds". There could be purely semantic, conceptual, or cognitive minds in contrast with other much more qualitative, non-conceptual, or experiential minds. There could be natural and artificial minds. There could be very simple minds and very sophisticated minds. There could be human minds and non-human minds, etc.

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(ML)

N

NEGANTROPY (S. *negantropía*, F. *néguentropie*, G. *Negentropie*) [statistical physics, biology]
concept

Negantropy is the negative value of the →*entropy*. Although the concept was first used by Erwin Schrödinger in 1943, who stated that "life feeds on negative entropy" (1944), the term "negantropy" was first coined by the French physicist Léon Brillouin (1953), who generalised the second law of thermodynamics as: in any transformation of a closed system, the quantity "entropy minus information" must always increase over time or may, at best, remain constant. Moreover, Brillouin's theory of information is considered as a consequence of the negentropy principle, which might be illustrated by the negentropy cicle: negentropy–information–decision–negentropy.

Criticizing the use of this term, Carl Friedrich von Weizsäcker stated: "Information has been correlated with knowledge, entropy with ignorance and consequently information has been labelled as negentropy. But this is a conceptual or verbal lack of clarity" (1985). To overcome such obscurity he distinguished between *potential information* (designated by Shannon's entropy) and *actual information*, which is factual and present. By knowing the macro-state of an object, the potential information is bounded; while the specification of its microstate is actual information (Lyre 2002).

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(JMD)

NON-INFORMATIONAL ACCESS (S. *acceso no informacional*, F. *schéma conceptuel*, G. *Begriffslandkarte*) [philosophy of mind, cognition]
concept

A non-informational access is an access that is not informational. Non-informational access may be physical or experiential. In that sense, informational access is in contrast both with physical access and with experiential –or qualitative- access. To have informational access to a certain amount of money is not the same as to have physical access to that amount of money. To have informational access to a certain state of pain is not the same either than to have an experiential access to that state of pain.

Of course, we can elaborate theories about information according to which information is identified with certain physical states or properties. In addition, we can elaborate theories about experience according to which experience is identified with some sorts of informational states. However, examples as those above presented show that such identifications would always involve very strong ontological compromises. Informational relations seem to be very different from physical relations, and very different too from qualitative, experiential or fenomenological relations.

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(ML)

ONTOLOGY (S. *ontologia*, F. *onmtologie*, G. *on-tologie* [Artificial Intelligence; Semantic Web] re-source, concept

Contents.— *1) Modelling techniques, 2) Ontology elements, 3) Ontology principles, 4) Ontology types*

According to Gomez-Perez (2004), Ontology definition has evolved during the last twenty years. In 1995, Guarino collects seven definitions about this concept to propose a new one. This author defines ontology as "a set of logical axioms designed to account for the intended meaning of a vocabulary" (Guarino, 1998).

One of the reasons for the disagreement is the broad definition that has been proposed to group all current ontologies. Wikipedia defines ontology as a "Formal representation of a set of concepts within a domain and the relationships between those concepts". These definitions might be right even for any other Knowledge Organization Systems or terminological resource. Wikipedia adds that ontologies are "used to reason about the properties of that domain, and may be used to define the domain".

The best known definition was proposed by Gruber: "a formal, explicit specification of a shared ontology." (1991).

1. Modeling techniques. Two are the most commonly used techniques:

— First-order logic

— Description logic

2. Ontology elements. Depending on the technique that has been used, the vocabulary to design some elements might be different.

— *Classes*: It is a set of similar individuals. These sets represent the main concepts of the domain. These concepts are often arranged in a hierarchical way. Classes might have attributes and functions and can be linked to another class by relations.

— *Relations*: Relationships to link classes and individuals

— *Attributes*: properties or slots those classes and its individuals can have.

— *Functions*

— *Individuals*: instances or objects of a class.

To perform inference, the existence of assertions considered true is needed: these assertions are used to express restrictions, rules and axioms.

Finally, the Events are a way to represent how the value of attributes and the relationships might change.

First order usually calls these elements: classes, relations, attributes (slots), functions, instances, and axioms.

Description Logic uses the following elements: concepts (equivalent to classes); roles (equivalent to relations and properties of concepts); and Individuals (equivalent to the instances of concepts and their properties).

3. Ontologies principles. To be able to share knowledge, interoperability is required. Many principles have been proposed (Gruber 1993):

— *Clarity*: objective definitions, formalized with axioms, and complete (necessary and sufficient conditions).

— *Minimal Encoding Bias*

— *Extendibility*

— *Minimal ontological commitments*

Gomez-Perez (2004) adds to this list:

— *Representing disjoints and exhaustive knowledge*
— *Minimizing distance between siblings*
— *Standardizing names in a clear form*

4. Types of Ontologies. There are different types of ontologies:

Upper ~ (**top** ~ or **foundational** ~): describe very general concepts that are common to all the ontologies. Other ontologies can be aligned with these concepts by their root term. Examples are DOLCE, Proton, SUMO, and CYC

Task ~: describe the vocabulary related to some generic task or activity.

Domain ~: concepts of a domain and their relationships.

Common ~(generic ontologies): common knowledge reusable in different domains. Examples are ontologies about time or space.

Knowledge Representation ~: primitives to express knowledge in a formalized way.

Application ~: it is an ontology adapted to a specific application.

Regarding the reusabilitity and usability, more abstract ontologies are highly reusable (Knowledge Representation Ontologies and Upper ontologies) but their usability is poor. Application and Domain Ontologies have a low reusability but a high level of usability.

5. Languages. Modeling choices are attached to different languages. As an example, one of the languages related to first order logic is KIF; OWL is usually related to frame logic. OWL is a language widely used to represent ontologies in the Web. OWL serialization is based on RDF/RDFS.

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(SSC –ed.-; JML)

OPEN ACCESS (S. *acceso abierto,* F. *accès ouvert,* G. *offener Zugang*) [research] theory

Contents.— *1) The Budapest account, 2) The Bethesda account, 3) The Berlin account, 4) Other accounts.*

There are three important definitions of Open Access, steemed from the declarations of Budapest, Bethesda and Berlin. The combination of these three accounts is regarded as the BBB definition of open access.

1. The Budapest account. According to the *Budapest Open Access Initiative* (BOAI 2002): "by 'open access' to this literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, scroll them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited".

2. The Bethesda account. The *Bethesda Statement on Open Access Publishing* (2003) adds that "An Open Access Publication is one that meets the following two conditions:

(i) The author(s) and copyright holder(s) grant(s) to all users a free, irrevocable, worldwide, perpetual right of access to, and a license to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any

responsible purpose, subject to proper attribution of authorship, as well as the right to make small numbers of printed copies for their personal use.

(ii) A complete version of the work and all supplemental materials, including a copy of the permission as stated above, in a suitable standard electronic format is deposited immediately upon initial publication in at least one online repository that is supported by an academic institution, scholarly society, government agency, or other well-established organization that seeks to enable open access, unrestricted distribution, interoperability, and long-term archiving.

3. The Berlin account. *Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities* (2003) confirms the above and offers the most theoretic perspective: "Our mission of disseminating knowledge is only half complete if the information is not made widely and readily available to society. New possibilities of knowledge dissemination not only through the classical form but also and increasingly through the open access paradigm via the Internet have to be supported. We define open access as a comprehensive source of human knowledge and cultural heritage that has been approved by the scientific community. In order to realize the vision of a global and accessible representation of knowledge, the future Web has to be sustainable, interactive, and transparent. Content and software tools must be openly accessible and compatible".

4. Other accounts. Besides these most influential accounts, it is also worth mentioning the following ones:

Steven Harnard, considered to be one of the founders of the Initiative, says "my definition is the same as that of the Budapest convention: «open access gives free online full-text access to peer-reviewed literature». This definition is lacking two important words though, immediate and permanent" (Harris 2006).

Robert Terry from Wellcome Trust (an independent charity funding research and United Kingdom's largest non-governmental source of funds for biomedical research) offers his own point of view: "we want the digital versions of papers to be available to all in an unrestricted way and for them to be available forever by putting it in an archive or institutional repository. Anyone who receives one of our grants has to put the digital versions of their published articles in PubMed Central (or in UK PubMed Central once it has been developed) on the day of publication or no later than six months after publication" (Harris 2006).

Martin Richardson, managing director of Oxford Journals, a division of Oxford University Press, states "our definition is freely-accessible online at point of publication without any charges to readers. Open access for me is much wider than just readers not paying" (Harris 2006).

Finally, *Michael Mabe* (who has been Elsevier's director of academic relations for the past seven years, and has now become chief executive officer of the International Association of Science, Technical and Medical Publishers -STM) states that "giving a definition goes to the heart of the problem with open access. In principle it is free availability to everybody on the world-wide web. However, many academics think they are accessing open-access material or publishing in open-access journals. They have not any barriers because their library has already paid for the subscription. In the industry as a whole there has not been an appreciable increase in downloads for open-access articles. This demonstrates that research papers are generally by academics for academics and they have access anyway" (Harris 2006).

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(LB)

P

PARADOX (S. *paradoja*, F. *paradoxe*, G. *Paradox, Paradoxon*) [transdiciplinary, philosophy, logic] concept

A paradox is a conflict between reasons: those grounding it and those refuting it. The more solid the reasons in conflict, the greater the philosophical interest of the paradox. In this general sense there are paradoxes of very different genres: (a) paradoxes challenging the intelligibility of particularly basic notions, such as: infinite, time, space, identity, etc.; (b) paradoxes challenging the rationality of our action or decision strategies: Newcomb's, Gaifman's paradoxes, prisioner's dilemma, etc.; (c) paradoxes challenging the rationality of our bodies of belief: selfdeceiving paradoxes, Goodman's , knower's paradoxes, etc.; among other many paradoxes, more or less important and more or less funny.

Logical paradoxes or antinomies are logically valid reasonings with non reasonable conclusions. Therefore we call antinomy any deductively valid reasoning driving to a contradiction from rationally justified, highly acceptable or assertable premisses.ones…

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(MV)

PRINCIPLES OF THE GTI (S. *principios de la teoría genral de la información*, F. *Principes de la Theórie Générale de l'Information*, G. *Grundsätze der Algemaine Theorie der Information*) [General Theory of Information] theory

The methodological stratum of the →*General Theory of Information (GTI)* studies basic principles of information theory and information technology.

Ontological Principle O1

(The *Locality Principle*). It is necessary to separate information in general from information (or a portion of information) for a system R.

In other words, empirically, it is possible to speak only about information (or a portion of information) for a system. This principle separates local and global approaches to information definition, i.e., in what context information is defined.

The Locality Principle explicates an important property of information, but says nothing what information is. The essence of information is described by the second ontological principle, which has several forms.

Ontological Principle O2

(The *General Transformation Principle*). In abroad sense, information for a system R is a capacity to cause changes in the system R.

Thus, we may understand information in a broad sense as a capacity (ability or potency) of things, both material and abstract, to change other things. Information exists in the form of portions of information.

Information in a proper sense is defined of structural infological systems. In essence, any

subsystem of a system may be considered as its infological system. However, information in a strict sense acts on structural infological systems where an infological system is structural if all its elements are structures. For example, systems of knowledge are structures.

Ontological Principle O2g

(The *Relativized Transformation Principle*). Information for a system R relative to the infological system IF(R) is a capacity to cause changes in the system IF(R).

Elements from IF(R) are called infological elements.

Ontological Principle O2a

(The *Special Transformation Principle*). Information in the strict sense or proper information or, simply, information for a system R, is a capacity to change structural infological elements from an infological system IF(R) of the system R.

An infological system IF(R) of the system R is called cognitive if IF(R) contains (stores) elements or constituents of cognition, such as knowledge, data, ideas, fantasies, abstractions, beliefs, etc. A cognitive infological system of a system R is denoted by CIF(R) and is related to cognitive information.

Ontological Principle O2c

(The *Cognitive Transformation Principle*).Cognitive information for a system R, is a capacity to cause changes in the cognitive infological system IFC(R) of the system R.

Ontological Principle O3

(The *Embodiment Principle*). For any portion of information I, there is always a carrier C of this portion of information for a system R.

The substance C that is a carrier of the portion of information I is called the physical, or material, carrier ofI.

Ontological Principle O4

(The *Representability Principle*). For any portion of information I, there is always a representation Cof this portion of information for a system R.

Ontological Principle O5

(The *Interaction Principle*). A transaction/transition/transmission of information goes on only in some interaction of C with R.

Ontological Principle O6

(The *Actuality Principle*). A system R accepts a portion of information I only if the transaction/transition/transmission causes corresponding transformations in R.

Ontological Principle O7

(The *Multiplicity Principle*). One and the same carrier C can contain different portions of information for one and the same system R.

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(MB)

R

RECORD (S. *registro*, F. *record*, G. *Rekord*, *Register*, *Eintragung*) [general, information management] concept

Records emerge in communities made up by autonomous agents, with limited memory capacities and in need of mutual coordination. To overcome such limitations of their memories and achieve effective coordination acts, such as contracts or agreements, agents need to set informations, definitions, ideas and meanings, in a way external to themselves and to their memories.

To achieve that, agents use records, physical systems whose state they may change. They define a convention that establishes two rule types. The first rule type defines how to modify a record's state starting from an information, a definition, an idea, etc., in order for the record to represent it. The second rule type defines how to interpret the information, definition, idea, etc., that the author had the intention to record, from the state of that record.

In human communities and given the fact that with very simple elements it is feasible to produce an overwhelming amount of states (for example, a sheet of paper with a pencil), conventions must reduce the allowed states to a very limited fraction of all feasible states. Generally, then, languages used are based on finite alphabets, words and grammars; and texts are written sequentially, and in parallel lines or rows, either vertically or horizontally, from left to right or in the opposite direction.

Records may be stable and have a long duration, as with books and CDs, or they may last only for short periods of time, as is the case of two persons chatting verbally. This conversation is performed interchanging auditive records, perturbations in the state of the air in which both persons are immersed. When a large number of records accumulate, they need organization and classification to make sure they are useful. This requirement is the basis of the Library and Information Systems sciences.

Records are not the same as information. They may represent it, but they are not information. The same information may be represented with many different record types. If all records representing a given information are destroyed, that information does not dissipate, it only gets more difficult (or infeasible) to access it.

A record may be false or true; exact or less exact; precise or less precise; valid or not valid. However, an information, taken as an abstract object, free of any representation form, is always true, exact, precise and valid.

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(RG)

REFERENTIAL ABILITY (S. *capacidad referencial*, F. *capacité référentielle*, G. *Referenzielle Fähigkeit*) [semantics, logic] concept

Referential ability is the capability of referring. We refer to something when we think or say something about it. Hence, we can refer to both existing and non-existing things (for instance, we can say many things about unicorns, and refer to them, even though they do not exist). In the same way, we can refer to properties, relations, events, states of affairs, etc.

Is our referential ability something always mediated by some sort of descriptions, senses, intensions, connotations, etc.? Does it have sense to say that, at least in some cases, we get to refer to the world in a direct, non-mediated way? An affirmative answer to the first question gives place to the so called "descriptivist theories of reference". An affirmative answer to the second one gives place to "non-descriptivist theories of reference", also called "theories of direct reference". Frege is the paradigmatic example of descriptivism. Russell and Kripke are paradigmatic examples of non-descriptivism. Stuart Mill also defended a non-descriptivis position. For that reason, being non-descriptivist is "to maintain a Millean theory of reference".

Orthogonal to the mentioned tension between descriptivist and non-descriptivist theories of reference, there are two main ways of explaining our referential ability. We can try to explain it as derived from some intentions or we can try to explain it as derived from some objective facts (for instance, causal facts, informational facts, etc.). The problem is that even if we were in the ideal situation of knowing all the possible truths about us ourselves and about the world, the references of the terms of our languages, and the references of our own thought, would remain indetermined. References could change without any change in the truth values of the sentences.

The situation we have just described would be a version of Quine's thesis about the indeter-

mination of reference. Truth value can be determined by the way things are. The world also can determine the references of our languages and thoughts. And references can determine truth values. There is, however, a radical indetermination of reference by truth values. Truth values do not determine references. Moreover, truth values do not determine that we get to refer. All the truth contained in an ideal description of the world would be compatible with the non-existence of such a world.

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(ML)

REGULARITY (S. *regularidad*, F. *régularité*, G. *Regelmäßigkeit*) [transdisciplinaryy, statistics, epistemology] concept

~ **Strict**: there is a strict regularity (Hume's constant conjunction) when each fact of a certain type A is accompanied by a fact of a certain type B. These types are determined by the universals instantiated in the facts.

~ **Statistical**: →*correlation.*

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(MC)

REPOSITORY (S. *repositorio*, F. *dépôt*, *référentiel*, G. *Aufbewahrungsort*) [scientific research, information society] concept

There is a wide variety of definitions of repository, but according to Melero (2005, p. 260), repositories can just be conceived as archives where people can store digital materials (text, images, sound). They emerge from the -so named- *e-print community* worried about the impact and dissemination of scholarly communication.

Repositories are digital archives containing scholarly information, generated from universities and other research institutions, that is open and accessible through the Internet. Repositories provide benefits to the scientific world and they are supported by a large number of institutions of many countries. They retrieve, reuse and preserve research outputs and promote disseminations and visibility of scholarly information, guaranteeing the advancement of Science.

López Medina (2007, p. 3) defines digital repository as a networking system constituted by hardware, software, data and processes with the following features:

— It contains digital objects and metadata.
— It guarantees the persistent identification of the object.
— It offers some roles of management, archive and preservation.
— It provides easy and standardized access to the digital objects.
— It offers safe system of objects and metadata.
— It is sustainable over time.

Most authors agree that there are two kinds of digital repositories: *discipline* or *subject based* repositories, and *institutional* repositories. The first type include contents depending on the subjects or knowledge areas. Lynch (2003) defines institutional repository as "a set of services that a university offers to the members of its community for the management and dissemination of digital materials created by the

institution and its community members. It is most essentially an organizational commitment to the stewardship of these digital materials, including long-term preservation where appropriate, as well as organization and access or distribution."

López Medina (2003) ascribes the following functions to institutional repositories:

— They are a shared tool for managing digital content in universities and other research institutions.
— A road to Open Access.
— A space for storage and preservation.

Melero (2005), in turn, ascribes them the following functions:

— They serve as a quality guarantee for the institution.
— They contribute to the dissemination, visibility, impact and preservation of the scholarly information.

Interoperability is another technical characteristics of institutional repositories. "The Open Archives Initiative (OAI) develops and promotes interoperability standards that aim to facilitate the efficient dissemination of content. OAI has its roots in the open access and institutional repository movements. Continued support of this work remains a cornerstone of the Open Archives program. Over time, however, the work of OAI has expanded to promote broad access to digital resources for eScholarship, eLearning, and eScience".

As Melero (2005, p. 261) states, the OAI promotes the building of open and distributed repositories containing, at least, descriptive metadata of their digital objects. It aims at creating and furthering interoperability standards, which contribute to an effective dissemination of the contents of the archives. The OAI-PMH (Open Archives Initiative-Protocol for Metadata Harvesting) "is a low-barrier mechanism for repository interoperability. *Data Providers* are repositories offering structured metadata via OAI-PMH; whereas *Service Pro-*

viders make OAI-PMH service requests to harvest such metadata. OAI-PMH is a set of six verbs or services that are invoked within HTTP".

The history of this protocol is described by Barrueco and Subirats (2003). The version 1.0 was published in 2001, and version 2.0 came out one year later. Its architecture is formed by *service providers* based on metadata harvested by means of the OAI metadata harvesting protocol (OAI-PMH) and *data providers* which are the specific repositories. All this information can be codified in Simple Dublin Core Metadata.

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(LB)

REPRESENTATION (S. *representación*) [transdisciplinaryy, epistemology] concept

Of all the things dubbed "representations" in ordinary language, we will be interested in the ones that, by design, are supposed, if they are successful, to express a content or proposition. We may call them propositional representations.

A second (see **correlation**) and more frequent use of the term "information" concerns the contents expressed by declarative tokens of languages or codes. We may call these tokens propositional representations. The content of a propositional representation —i.e., the proposition expressed by it, or what it says to competent users of the language— is frequently referred to as the information carried by the representation. In contrast with what happens with the former notion of information, the content carried by a propositional representation doesn't depend on the existence of any correlation, but on the design history of the corresponding language or code. In this view, also, contents can be false, and a propositional representation may thus carry false information.

While in the case of the first notion of information, it seems that it could be reduced to the idea of correlation, in the case of the second notion, it seems that it could be reduced to the idea of content.

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(MC)

REVERSIBILITY vs NON-REVERSIBILITY (S. *Reversibilidad vs Irreversibilidad*, F. *Reversibilité vs Ireversibilité*, G. *Reversibilität vs Unreversibilität*) [transdisciplinary, System theory] concept

Reversibility and Non-reversibility or *Irreversibility* are properties of systems with respect to inner changes. In a rigid analysis there is never such a thing like complete reversibility, because on the macro-level and for physical systems the stream of time cannot be reverted, i.e. in the space-time continuum only movements toward increasing points in time are possible. If we abstract from time, still pure reversibility is impossible in closed systems —

as we know from thermodynamics-because any change which is accompanied by a difference cannot be performed without a loss of energy, and, in general, with an increase of entropy (although according to Ilya Prigogine a decrease of entropy = an increase of order could be possible locally). As far as we know today, irreversibility is a general property of all processes in evolution: on the cosmic, geological, phylo-genetic, onto-genetic, social or economic levels. Reversibility can only happen if we abstract from energy/entropy changes.

For practical purposes it is important to know if qualitative or quantitative changes can be compensated or not. (e.g. pathological changes in tissue or organs, chemical reactions). Jacob Segal (1958) gives the following degrees of reversibility:

1) spontaneous and directly revertible processes (with losses in time and energy)

2) spontaneous and indirectly revertible processes (on different pathways than under 1.)

3) non-spontaneous, but directly revertible processes (additional energy necessary)

4) non-spontaneous, but indirectly revertible processes (new side-conditions needed)

5) absolutely irreversibility

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(PF)

ROBOETHICS (S. *roboética*, F. *roboéthique*, G. *Roboethik*) [Information ethics] theory

As Capurro and Nagenborg (2009) state, ethics and robotics are two academic disciplines, one dealing with the moral norms and values underlying implicitly or explicitly human behaviour and the other aiming at the production of artificial agents, mostly as physical devices, with some degree of autonomy based on rules and programmes set up by their creators. Since the first robots arrived on the stage in the play by Karel Čapek (1921) visions of a world inhabited by humans and robots gave

rise to countless utopian and dystopian stories, songs, movies, and video games.

Human-robot interaction raises serious ethical questions right now that are theoretically less ambitious but practically more important than the possibility of the creation of moral machines that would be more than machines with an ethical code. But, even when the process of invention and development of robotic technologies take place in a global level, in which diverse cultures, therefore also diverse systems of values, beliefs and expectations are involved, intercultural roboethics is still in its infancy, no less than intercultural robotics (→*Intercultural Information Ethics*).

Rougly speaking, the following ethical theories and moral values as well as principles are predominant in Western and Eastern traditions rising different questions with regard to human-robot interaction such as:

— Europe: Deontology (Autonomy, Human Dignity, Privacy, Anthropocentrism): Scepticism with regard to robots

— USA (and anglo-saxon tradition): Utilitarian Ethics: will robots make "us" more happy?

— Eastern Tradition (Buddhism): Robots as one more partner in the global interaction of things

The difference morality and ethics should be understood as follows:

— Ethics as critical reflection (or problematization) of morality

— Ethics is the science of morals as robotics is the science of robots

Different ontic or concrete historical moral traditions are for instance

— in Japan: *Seken* (trad. Japanese morality), *Shakai* (imported Western morality) and *Ikai* (old animistic tradition)

— In the „Far West": Ethics of the Good (Plato, Aristotle), Christian Ethics, Utilitarian Ethics, Deontological Ethics (Kant)

The ontological dimension, Being or (Buddhist) Nothingness, can be conceived as the

space of open possibilities that allow us to criticize concrete or 'ontic' moralities. The human relation to such ontological dimension is always based on basic moods (like sadness, happiness, astonishment etc.) through which the uniqueness of the world and human existence is experienced differently in different cultures. A future intercultural roboethics should reflect on the ontic as well as on the ontological dimensions for creating and using robots in different cultural contexts and with regard to different goals. Trends, contributions and bibliography focused in this crossroad can be found in the mentioned book, edited by Capurro and Nagenborg.

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(RC)

S

SELF-RE-CREATION (S. *auto-re-creación*, F. *auto-ré-création*, G. *Selbst-Re-Kreation*) [UTI] concept

Used in the →*Unified Theory of Information* (UTI) as one of the three basic processes of information systems –the most advanced one.

Self-recreation is a more elaborated type of →*self-reproducing* processes and refers to the capacity of self-organizing systems to create the necessary conditions, not only for their reproduction, but also to create themselves according to the objectives that they have established themselves. In their capacity to change the environment for their own settlement, they show an even bigger capacity to adapt than the systems that are merely biotic (→*self-reproducing*) of which they are part. Thus they involve the most advanced evolutionary stage (or stage of cultural *evolution*).

They can be classified as *self-determining* insofar as their self-organising capacities offer, under certain circumstances, a set of possibilities, which can be chosen by themselves. Given the fact that such a choice takes the form of a decision adopted under the condition of an irreducible freedom of choice, the pragmatic and semantic levels are separated. Consequently, in the stage of social, self-recreating and self-determining systems, the semiotic relationship spreads in its three levels of sign production, which can be described in terms of the creation of ideas. Such creation happens in three stages: 1st) the perception of signals from outside the system causes the appearance of a sign, which is a modification of the system's structure; 2nd) the interpretation of the perceptions by which the system's state is modified and another sign emerges, meaning something that is given to the system as its object; 3rd) the

evaluation of the interpretations that cause another sign to emerge, by means of which the system -as subject- completes its meaning, considering the object as an initial state to reach the end and affects the behaviour of the system so that it can be modified.

The sign, in each of these three levels, is called (in UTI) →*data*, →*knowledge* and *wisdom* (or practical wisdom), respectively, each one corresponding to the field of the perceptive, cognitive and evaluative capacities, which together make up the characteristics of conscience, which appears in systems. In each stage, a break in the self-organisation occurs, which is a starting point for another one to occur (or not occur) afterwards.

Self-organising systems on the human, social, cultural level are capable of constructing themselves anew, inventing themselves, creating themselves again and again. Erich Jantsch called this capability "re-creative". Thus "re-creative systems" are a branch of autopoietic systems that leads to a new level: (Self-)Re-creation is a refinement of, and further development in, autopoietic self-organisation (self-reproducing).

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(WH –ed.-; JMD, WH)

SELF-REGULATION VS AUTOMATIC REGULATION (S. *auto-regulación vs. regulación automática*, F. *Autorégulation vs. régulation automatic*, G. *Selbstregelung vs. automatische Regelung*) [System Theory, Cybernetics, Control Theory] concept

Contents.— *1) The semantic field of self-regulation, 2) Brief history of automatic regulation, 3) Industrial automation, 4) Social regulation of automation.*

1. The semantic field of self-regulation.
Self-regulation (or automatic regulation) is used in systems theory and cybernetics in the sense of **homeostasis** (→*feedback*), namely the capacity of a system to maintain itself in a balanced situation.

In this sense the term is very commonly used in psychology, though not in the meaning of "*automatic regulation*", but as "regulation of the self", also named self-control (i.e. the ability to control one´s emotions, desires or actions by one's own will). Since automatic is used in a sense of acting without volition or conscious control, there is a certain semantic opposition between the psychological meaning of "self-regulation" or "self-control", on one hand, and "automatic regulation" or "automatic control", on the other hand.

Automatic regulation, also used in the sense of an autonomous maintenance of a balanced situation, is mainly found in the field of electronic systems and control engineering (*control theory*).

2. Brief history of automatic regulation.
The concept of automated machines goes back to ancient times, related to myths of living mechanical beings. Automata, or machines like people, appeared in clocks of medieval churches, being 18th century watchmakers well-known for their smart mechanical creatures.

Some of the first automata utilized feedback mechanisms to reduce errors, mechanisms that are still used nowadays. Among the first devices of automatic control registered in the literature, we found in Heron's *Pneumatica* (c.150 b.C.) a control for the liquid level in a tank which is similar to what is currently used in toilette's tanks. The Greek-Byzantine tradition -symbolised by Hero and the School of Alexandria- was developed in the Islamic world, going significantly beyond (Rashed & Morelon 1996). Some relevant automatic regulated systems can be found in the literature, for instance, from the inventor and scientist Al-Jazari (c.1206), whose water clocks represent a distinguished evolution of Hero's level control, or the Andalusian engineer Ibn Khalaf al-Muradi, who invented segmental and epicyclic gears employed in clocks. These developments influenced in Christian Middle Ages, where some relevant inventors, who sometimes had to hide their artefacts, might be considered as predecessors of automation, as Albertus Magnus, Pierre de Maricourt or Roger Bacon (Bacon 1859).

However, there was a lack of theoretical and mathematical development behind all these inventions. The first work of what can be called a *classical control theory* is to be found in a significant work concerning the centrifugal gobernor of Boulton and Watt designed in 1788 (Rumford 1798). This device consisted of two metal balls attached to the drive shaft of a steam engine and connected to a valve regulating the flow of steam. As the speed of the steam engine is increased, the balls are moving out of the shaft because of centrifugal force, thereby closing the valve. This caused a decline in the flow of steam to the engine and therefore the speed will be reduced.

3. Industrial Automation.
The feedback control, the development of specialized tools and distribution of work into smaller tasks that workers or machines might handle, were es-

sential ingredients in the automation of industry in the eighteenth century. As technology improved, specialized machines were developed for tasks such as putting caps on bottles or pour liquid into molds for rubber tires. However, none of these machines have the versatility and efficiency of the human arm and could not reach distant objects and place them in the required position.

An *automated manufacturing system* is designed to use the capacity of machines to perform certain tasks previously tackled by humans, and to control the sequence of operations without human intervention. The term *automation* has also been used to describe non-manufacturing systems in which programmed or automated devices can operate independently or semi-independently of human control. In communications, aviation and astronautics, devices such as automatic telephone switching equipment, autopilots, and automated systems guidance and control are used to perform different tasks faster or better than human beings.

4. Social regulation of automation. Following an uncritical dominant concept of social progress, automation is considered as one of their pillars, increasing productivity and reducing human drudgery, therefore improving general welfare. Nevertheless, the political, societal and anthropological problems arisen with industrial automation –as early warned by Norbert Wiener (1989)- must be considered in order to evaluate and steer the paths of automation. This critical appraisal might be conceived as a means to achieve a social self-regulation (in the sense stressed above) to this concern. However, as Noble (1993) argues in his *Automation Madness,* such a critical stance has been systematically evaded as well as encapsulated in technological ideology (Habermas 1970). According to Noble analysis, the adoption of automation did not really account for economical benefits, but for military, power and class interests.

Going beyond industrial automation, new →*information technologies* have been posed as the *automation of intellectual work* (Diani 1996). New

social problems arisen from this perspective should also be tackled in a wide critical assessment, reflection and decision-making on automation of any kind (Chollet and Rivière 2010). Both ethics and critical theory has been posed as stages for these social endeavours (→*Critical theory of information,* →*information ethics,* →*roboethics*).

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(BH –ed.-; JMD, BH)

SELF-REPRODUCTION (S. *autoreproduc-ción*, F. *autoreproduction*, G. *Selbstreproduktion*) [UTI]_{concept}

Used in the →*Unified Theory of Information (UTI)* as an intermediate process -in evolutionary sense- of information systems

Self-reproduction is a more elaborated type of self-restructuring processes and refers to the capacity of self-organising systems, which do not only change their structure into another one more or less chosen by themselves, but they also insert these modified structures into a wider context: that of helping them to keep their own existence. Here, a functional structure is not a simple pattern any more, but a 'thing' that has meaning, and this 'thing' will be called here a symbol, so that the production of signs in this evolutionary stage of living systems changes from creating patterns to creating symbols.

The self-reproducing systems are considered an evolutionary stage (called biotic or living) among the →*self-restructuring* and the →*self-recreating* ones, so that they involve a special case of self-restructuring systems, as well as a more general case than the self-recreating ones.

As far as the evolution of the *semiotic* relation is concerned, one can observe here a ramification in which the syntactic level is separated from the semantic-pragmatic one, regarding the former just to the sensations of the living systems. These sensations -on the syntactic level- consist of self-organised restructurings evoked by the environmental disruptions and limited by the "offer of sensitive mechanisms" in a recursive process of symbolic production. However, on the semantic-pragmatic level, actions are developed according to sensations. Since living systems act according to what such sensations mean in terms of relevance for survival, we could talk about both meaning and action, although in an indissoluble manner. The syntactic difference means -in practice- a difference with regard to the objective of the survival, so that the signs now represent the aptitude of the system towards the envi-

ronmental conditions (whereas in the self-restructuring systems one talks about reflection, one could talk here about representation).

Self-organising systems on the biotic level are capable of reproducing themselves. Notice that "reproduction" in that context is not the same as to what biologists are used to referring. The notion here includes the narrow biological meaning of reproduction but goes beyond that. It refers to the capability of the system to maintain itself — a meaning that usually comes with the notion in sociological context only. This kind of reproduction can be called after Maturana and Varela "→*autopoiesis*". Therefore living systems can be called "autopoeitic systems". Autopoiesis is a refinement of, and further development in, dissipative self-organisation (self-restructuring).

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(WH –ed.-; JMD, WH)

SELF-RESTRUCTURING (S. *auto-restructuración*, F. *autorestructuration*, G. *Selbst-restrukturierung*) [UTI]_{concept}

Used in the →*Unified Theory of Information* as the lowest capacity of information systems.

Self-restructuring is the most primitive type of *self-organising processes*, in which the most primitive manifestation of signs also occurs. This type of systems is also called dissipative, because, in thermodynamic terms, they dissipate

the entropy as a sub-product of the work carried out during the restructuration, in which, at the same time that the energy degrades, the system manages to get rid of it. This is necessary for the new structure to be considered a creation of a superior order, instead of a degradation of the system. The structuring process leads to a special and/or temporal pattern.

Understood as information processing, the creation of patterns is the rudimentary way of producing signals, being the pattern the distinction carried out by the system in which the three semiotic relations can be found (→*sign*): 1st) a syntactic relation can be observed, insofar as the creation of the pattern is a type of recursive process which builds on the previous pattern and chooses one amongst various possible patterns; 2nd) as far as the incoming energy allows the system to change its pattern, the input becomes a signal that makes the new pattern arise, although it does not establish it completely. The state adopted by the system when creating a new pattern can be interpreted as a representation of the input, thus it can be said it is a semantic relationship. 3rd) As long as the new pattern corresponds to the observable behaviour in which the system expresses its activity, the pragmatic relation remains also thematised here.

However, the three semiotic relationships coincide with the pattern and, therefore, they are not differentiated yet. It can be said that the pattern reflects the conditions of its environment, as the pattern depends on it. Such reflection of the environment constitutes a precondition for the appearance of a sphere of influence in which the behaviour of the system launches that of the adjacent ones, so that the appropriate conditions can emerge for the maintenance and improvement of the system, which will be possible in →*self-reproducing* systems.

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(WH –ed.-; JMD, WH)

SEMANTIC CONTENT (S. *contenido semántico*, F. *contenú sémantique*, G. *semantischer Inhalt*) [semantics] concept

Semantic content, conceptual content, propositional content and cognitive content are synonymous in many contexts. It is a kind of content directly valuable in semantic terms (as having a reference, a sense, some truth values, etc.). It is a content made of concepts. Moreover, it is a content identifiable with a certain proposition. In addition, it is a kind of content able of having cognitive relevance. It makes a difference in the premises, or consequences, of our theoretical or practical reasoning.

The three kinds of entities able of having semantic content are linguistic items, actions and psychological entities. Sentences and certain parts of sentences of natural languages may bear semantic content. Actions, in particular speech acts, also would have semantic content. Finally, the mental states that are usually called "propositional attitudes" (beliefs, desires, memories, etc.) also would have semantic content.

It is very difficult to determine whether the semantic content in each one of those three cases can be independent of the semantic content of the other ones. Both the so called Gricean program and informational accounts of semantic content make any semantic content dependent on the semantic content that we can find in some mental states, and the semantic content of mental states dependent on objective informational relations.

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(ML)

SEMANTIC WEB (S. *web semantica*, F. *web sémantique*, G. *semantisches Web*) [Web] concept

Contenidos.— 1) Evolución, limitaciones y virtudes de la propuesta, 2) Capas de la Web Semántica, 3) El Estándar Topic Map y la Web Se-mántica.

1. Evolution, limitations and advantages of the proposal. Tim Berners-Lee created this concept by proposing a network in which information and services are semantically defined so that requests of people and machines could be understood and satisfied. Computers would be able to analyze all Web data: content, links, transactions between persons and computers. A Semantic Web that could be able to do this is emerging, and this way, when this is possible there will be a qualitative leap in the interconnection between multiple repositories, electronic commerce, semantic queries and automatic question-answer systems.

Semantic Web has already been with us for a decade and a great effort has been invested for its development by private and academic entities, but regretfully results are currently scarce, because this forward-looking approach implicates a "technical construct of protocols, process, languages, and tools.

However, three factors present Semantic Web as an attractive solution; these are the interoperability and the creation of semantic resources with the common domain knowledge:

i) *Interoperability*: some authors consider the Semantic Web as a project for creating a universal mediator for information interchange (Kalfoglou, 2007). This would be possible through the creation of interoperable documents semantically well defined for the computer applications of the World Wide Web. In other words, it is about converting the Web, and its distributed databases, into a great database. Interoperability between the documents is sustained through the use of a common language based on RDF (Resource Description Framework) (W3C, 2005), a language which is based on XML (Extensible Markup Language) (W3C, 2006). The advantages of obtaining this interoperability are obvious for knowledge reuse (Russ, Jones and Fineman, 2006), conceptual navigation, and the fusion of Knowledge Organization Systems (KOS) through multiple domains (W3C, 2006; Zeng, 2004).

ii) *Semantic Resources*: Semantic Web requires that the semantic knowledge should be expressed in documents written in a Web language oriented to knowledge modeling, like RDF. These documents model KOS and its instances. KOS have an important role in the Semantic Web because they support the semantic knowledge management. This is necessary to perform indexing and retrieval tasks, giving as a result more relevant and noiseless information for the user. KOS define the concepts utilized for describing and representing an area of knowledge (Daconta, Smith and Obrst, 2003; Gruber, 2005). These resources are used by persons, databases, and applications that need to share information on a specific domain, considering for every domain the specification of a knowledge area, such as medicine, real estate, commercial management, etc.

2. Semantic Web Layers. Semantic Web proposal suggests a seven layer "cake" for its implementation. Each layer has to be compatible with previous ones. For instance, the layer three -RDF/RDFS- must be understood by XML applications, while the next layer, usually encoded by OWL, must be able to extract information from RDF documents.

Although the following layer scheme correspond to the most well known version of the cake, other versions has also been proposed (Bratt, 2007):

1) **Unicode-URI**: basic coding and resource identification.

2) **XML-NS-XMLSchema**: syntax and its relationship with name-spaces, also expressing XML structure.

3) **RDF+RDFSchema**: RDF/RDFS shows primitives to represent knowledge.

4) **Ontology Vocabulary**: structuring and classifying concepts by an ontology.

5) **Logic**: axioms and monotonic rules.

6) **Proof**: to validate assertions

7) **Trust**: trustworthiness of the data.

3. Topic Map Standard and Semantic Web. Topic Maps standard constitutes a proposal similar in purpose but earlier in its roots. This standard was proposed at the beginning of the 1990s. Nowadays the proposal have been updated to recommend XML encoding and other improvements. Although this proposal has lower inference capabilities, it is more intuitive. With the same objective of metadata vocabularies, this standard initially used Public Subject Indicators (PSI).

Related Resources

— Swoogle http://swoogle.umbc.edu/
— Hakia http://www.hakia.com/
— Eyeplorer http://www.eyeplorer.com/eyePlorer/
— World Wide Web Consortium (W3C) http://www.w3c.org

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(SSC –ed.-; JML, YA, AFV)

SHANNON, CLAUDE ELWOOD [MTC, Information theory, engineering, communication, cryptography] author

Contents.— *1) Formative years, 2) The impact of World War II, 3) From Cryptography to Communication Theory, 4) Entropy and Information, 5) Shannon as a Pioneer in Artificial Intelligence, 6) A Complex Legacy.*

(*b.* Petoskey, Michigan, 30 April 1916, *d.* Medford, Massachusetts, 24 February 2001).

Shannon is first and foremost known as a pioneer of the information age, ever since he

demonstrated in his seminal paper "A Mathematical Theory of Communication" (1948) that information could be defined and measured as a scientific notion. The paper gave rise to "information theory," which includes metaphorical applications in very different disciplines, ranging from biology to linguistics via thermodynamics or quantum physics on the one hand, and a technical discipline of mathematical essence, based on crucial concepts like that of channel capacity, on the other. Shannon never showed much enthusiasm for the first kind of informal applications. He focused on the technical aspects and also contributed significantly to other fields such as cryptography, artificial intelligence, and domains where his ideas had their roots and could be readily applied in a strict fashion, that is, telecommunications and coding theory.

1. Formative Years. Claude Elwood Shannon was the son of Claude Shannon Sr. (1862–1934), a businessman who was also a judge of probate, and Mabel Wolf Shannon (1880–1945), a high school principal. Until the age of sixteen, he lived in Gaylord, Michigan, where his mother worked. His youth was to prove a decisive influence on his life as a scientist: his grandfather was a tinkerer, possessed a patent on a washing machine, and created various—sometimes nonsensical—objects. By the time he graduated from high school, the young Shannon had already built a radio-controlled boat and a telegraphic system to communicate with a friend nearly a mile away, using barbed wires. He made some pocket money by fixing various electrical devices, such as radios, and he admired Edison, with whom he discovered later that he shared a common ancestor.

Shannon left Gaylord in 1932 for the University of Michigan, where he studied both electrical engineering and mathematics, obtaining in 1936 a bachelor of science degree in both fields. He then found a way to match his tinkering capacities with his knowledge in electrical engineering, working in the Department of Electrical Engineering at the Massachusetts Institute of Technology (MIT) on the maintenance of the differential analyzer that had

been constructed by Vannevar Bush (1890–1974). Bush was to become his mentor over the next decades. It was in Bush's department that Shannon wrote his master's thesis, titled "Symbolic Analysis of Relay and Switching Circuits," which he submitted on 10 August 1937. In an interview, Shannon recalled in 1987:

> "The main machine was mechanical with spinning disks and integrators, and there was a complicated control circuit with relays. I had to understand both of these. The relay part got me interested. I knew about symbolic logic at the time from a course at Michigan, and I realized that Boolean algebra was just the thing to take care of relay circuits and switching circuits. I went to the library and got all the books I could on symbolic logic and Boolean algebra, started interplaying the two, and wrote my Master's thesis on it. That was the beginning of my great career!" (Sloane and Wyner, eds., 1993, p. xxv)

The insight was decisive: It constituted "a landmark in that it helped to change digital circuit design from an art to a science" (Goldstine, 1972, p. 119). His study dealt with the circuits based on relays and switching units, such as automatic telephone exchange systems or industrial motor equipment. He developed rigorous methods for both analysis and synthesis of circuits, showing how they could be simplified. At this time, he probably had his first intuitions on the relations between redundancy and reliability, which he was to deepen later. That his stance was both theoretical and practical becomes clear at the end of his master's thesis, where he illustrated his approach with five circuits: a selective circuit, an electronic combination lock, a vote counting circuit, a base-two adder, and a factor table machine.

This dual approach was also revealed in an important letter that Shannon sent to Bush in February 1939. He wrote that "Off and on [he had] been working on an analysis of some of the fundamental properties of general systems for the transmission of intelligence, including telephony, radio, television, telegraphy, etc."

He stated that "Practically all systems of communication may be thrown into the following form: $f_1(t) \rightarrow \boxed{T} \rightarrow F(t) \rightarrow \boxed{R} \rightarrow f_2(t)$; $f_1(t)$ is a general function of time (arbitrary except for certain frequency limitations) representing the intelligence to be transmitted. It represents for example, the pressure-time function in radio and telephony, or the voltage-time curve output of an iconoscope in television."

Shannon was awarded the Alfred Noble Prize of the American Society of Civil Engineers for his master's thesis in 1940. He continued to work on the use of algebra to deepen analogies and began his doctoral studies in mathematics, with the same supervisor, the algebraist Frank L. Hitchcock. The topic, however, stemmed from Bush, who suggested that Shannon apply Boolean algebra to genetics, as he had to circuits. The result of his research was submitted in the spring of 1940 in his thesis "An Algebra for Theoretical Genetics." Meanwhile, Shannon had also published his "Mathematical Theory of the Differential Analyzer" (1941) and during the summer of 1940 had started working at the Bell Laboratories, where he applied the ideas contained in his master's thesis. He also spent a few months at the Institute for Advanced Study in Princeton working under Hermann Weyl thanks to a National Research Fellowship, and he then returned to the Bell Labs, where he worked from 1941 to 1956.

2. The Impact of World War II.

Any scientist who worked in public institutions, private companies, or universities at this time became increasingly engaged in the war effort. From 1940 onward, interdisciplinary organizations were founded: first the National Defense Research Committee (NDRC, June 1940), under the supervision of Vannevar Bush, and later the Office of Scientific Research and Development (May 1941), which included the NDRC and medical research. Shannon soon became involved in this war-related research, mainly with two projects. The first project focused on anti-aircraft guns, which were so important in defending Great Britain under the V1 bombs and V2 rockets and more generally for air defense. Because World War II planes flew twice as high and twice as fast as those of World War I, the fire control parameters had to be automatically determined by means of radar data. Shannon was hired by Warren Weaver, at the time also head of the Natural Sciences Division of the Rockefeller Foundation. He worked with Richard B. Blackman and Hendrik Bode, also from Bell Labs. Their report, "Data Smoothing and Prediction in Fire-Control Systems," pointed in the direction of generality in signal processing. Fire control was seen as "a special case of the transmission, manipulation, and utilization of intelligence." They stated that there was "an obvious analogy between the problem of smoothing the data to eliminate or reduce the effect of tracking errors and the problem of separating a signal from interfering noise in communications systems" (Mindell, Gerovitch, and Segal,2003, p. 73).

The second project was in the field of cryptography. At the outbreak of the war, communications could be easily intercepted. The main transatlantic communication means for confidential messages was the A3 telephone system developed at Bell Labs, which simply inverted parts of the bandwidth and was easily deciphered by the Germans.Shannon worked on the X-System, which solved this problem, and met British mathematician Alan Turing during this time. Turing had come to Bell Labs to coordinate British and American research on jamming, but the "need-to-know" rule that prevailed prevented them from engaging in a real exchange on these issues. The quintessence of Shannon's contribution to war cryptography can be found in a 1945 report (declassified in 1957) titled "A Mathematical Theory of Cryptography," which outlined the first theory, relying on both algebraic and probabilistic theories. Shannon explained that he was interested in discrete information consisting of sequences of discrete symbols chosen from a finite set. He gave definitions of redundancy and equivocation, and also of "information." Trying to quantify the uncertainty related to the realization of an event chosen among n events for which a probability pi is known, he

proposed the formula $H=\Sigma i(i=1..n)\{pi \log pi\}$ where H was at first merely a measure of uncertainty. He then showed that this formula verified eleven properties such as additivity (information brought by two selections of an outcome equals the sum of the information brought by each event) or the fact that H was maximum when all the events had the same probability (which corresponds to the worst case for deciphering). For the choice of the letter H, obviously referring to Boltzmann's H-Theorem, he explained that "most of the entropy formulas contain terms of this type" (Sloane and Wyner, 1993, pp. 84–142). According to some authors, it might have been John von Neumann who gave Shannon the following hint:

"You should call it entropy, for two reasons. In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important, no one really knows what entropy really is, so in a debate you will always have the advantage." (Tribus, 1971, p. 179)

3. From Cryptography to Communication Theory. In his 1945 memorandum, Shannon also developed a general schema for a secured communication. The key source was represented as a disturbing element conceptualize as a "noise," similar to the message, but apart from that, the schema was similar to the one he described in 1939 in his letter to Bush. Shannon always kept this goal in mind, even when he worked in cryptology. In 1985, Shannon declared to Price "My first getting at that was information theory, and I used cryptography as a way of legitimizing the work. ... For cryptography you could write up anything in any shape, which I did" (Price, 1985, p. 169)

Relying on his experience in Bell Laboratories, where he had become acquainted with the work of other telecommunication engineers such as Harry Nyquist and Ralph Hartley, Shannon published in two issues of the Bell System Technical Journal his paper "A Mathematical Theory of Communication." The general approach was pragmatic; he wanted to

study "the savings due to statistical structure of the original message" (1948, p. 379), and for that purpose, he had to neglect the semantic aspects of information, as Hartley did for "intelligence" twenty years before (Hartley, 1928, p. 1). For Shannon, the communication process was stochastic in nature, and the great impact of his work, which accounts for the applications in other fields, was due to the schematic diagram of a general communication system that he proposed. An information source" outputs a "message," which is encoded by a "transmitter" into the transmitted "signal." The received signal is the sum of the transmitted signal and unavoidable "noise." It is recovered as a decoded message, which is delivered to the "destination." The received signal, which is the sum between the signal and the "noise," is decoded in the "receiver" that gives the message to destination. His theory showed that choosing a good combination of transmitter and receiver makes it possible to send the message with arbitrarily high accuracy and reliability, provided the information rate does not exceed a fundamental limit, named the "channel capacity." The proof of this result was, however, nonconstructive, leaving open the problem of designing codes and decoding means that were able to approach this limit (→*Shannon's fundamental theorems*).

The paper was presented as an ensemble of twentythree theorems that were mostly rigorously proven (but not always, hence the work of A. I. Khinchin and later A. N. Kolmogorov, who based a new probability theory on the information concept). Shannon's paper was divided into four parts, differentiating between discrete or continuous sources of information and the presence or absence of noise. In the simplest case (discrete source without noise), Shannon presented the H formula he had already defined in his mathematical theory of cryptography,which in fact can be reduced to a logarithmic mean. He defined the bit, the contraction of "binary digit" (as suggested by John W. Tukey, his colleague at Bell Labs) as the unit for information. Concepts such as

"redundancy," "equivocation," or channel "capacity," which existed as common notions, were defined as scientific concepts. Shannon stated a fundamental source-coding theorem, showing that the mean length of a message has a lower limit proportional to the entropy of the source. When noise is introduced, the channel-coding theorem stated that when the entropy of the source is less than the capacity of the channel, a code exists that allows one to transmit a message "so that the output of the source can be transmitted over the channel with an arbitrarily small frequency of errors." This programmatic part of Shannon's work explains the success and impact it had in tele-communications engineering. The turbo codes (error correction codes) achieved a low error probability at information rates close to the channel capacity, with reasonable complexity of implementation, thus providing for the first time experimental evidence of the channel capacity theorem (Berrou and Glavieux, 1996).

Another important result of the mathematical theory of communication was, in the case of a continuous source, the definition of the capacity of a channel of band W perturbed by white thermal noise power N when the average transmitter power is limited to P, given by

$$C = W \log\{(P+N)/N\}$$

which is the formula reproduced on Shannon's gravestone. The 1948 paper rapidly became very famous; it was published one year later as a book, with a postscript by Warren Weaver regarding the semantic aspects of information.

4. Entropy and Information. There were two different readings of this book. Some engineers became interested in the programmatic value of Shannon's writings, mostly to develop new coding techniques, whereas other scientists used the mathematical theory of communication for two reasons: on one hand, a general model of communication; and on the other, the mathematical definition of information, called "entropy" by Shannon. Those ideas coalesced with other theoretical

results hat appeared during the war effort, namely the idea of a general theory for "Control and Communication in the Animal and the Machine," which is the subtitle of Cybernetics, a book Norbert Wiener published in 1948. Shannon, von Neumann, Wiener, and others were later called "cyberneticians" during the ten meetings sponsored by the Macy Foundation, which took place between 1946 and 1953. Shannon and Weaver's 1949 book, along with the work by Wiener, brought forth a so-called "information theory."

Rapidly, connections were made between information theory and various fields, for instance in linguistics, where influences went in both directions. In order to be able to consider "natural written languages such as English, German, Chinese" as stochastic processes defined by a set of selection probabilities, Shannon relied on the work of linguists, who, in turn, were vitally interested in the calculus of the entropy of a language to gain a better understanding of concepts like that of redundancy (Shannon, 1951). Roman Jakobson was among the most enthusiastic linguists; he had participated in one of the Macy meetings in March 1948. At the very beginning of the 1950s, in most disciplines, new works were presented as "applications" of information theory, even if sometimes the application only consisted of the use of logarithmic mean. Trying to understand the connections between molecular structure and genetic information—a couple of months before the discovery of the double helix for the structure of DNA—Herman Branson calculated, in a symposium entitled "The Use of Information Theory in Biology," the information quantity (H) contained in a human. He gave the expression "H (food and environment) = H (biological function) + H (maintenance and repair) + H (growth, differentiation, memory)" (Quastler, 1953, p. 39). Henry Quastler came to the conclusion, as did Sidney Dancoff, that "H (man)" was about 2 x 10 28 bits (p. 167).

Taking issue with these different kinds of applications, Shannon in 1956 wrote a famous editorial, published in the Transactions of the

Institute of Radio Engineers, with the title "The Bandwagon." As he stated, referring to his 1948 paper, "Starting as a technical tool for the communication engineer, it has received an extraordinary amount of publicity in the popular as well as the scientific press. In part, this has been due to connections with such fashionable fields as computing machines, cybernetics, and automation; and in part, to the novelty of its subject matter. As a consequence, it has perhaps been ballooned to an importance beyond its actual accomplishments." At this time, some applications of information theory already reflected a mood, essentially based on a loose, rather than a scientific definition of information. Forty years later, the project of "information highways," presented to promote the Internet, partly relied on the same idea.

5. Shannon as a Pioneer in Artificial Intelligence. At the time Shannon published his relatively pessimistic editorial, he was already engaged in other research, typically related to his ability to combine mathematical theories, electrical engineering, and "tinkering," namely, artificial intelligence. Shannon coauthored the 1955 "Proposal for the Dartmouth Summer Research Project on Artificial Intelligence," which marked the debut of the term "artificial intelligence." Together with Nathaniel Rochester, John McCarthy, and Marvin L. Minsky, he obtained support from the Rockefeller Foundation to "proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it." In explaining his own goal, Shannon named two topics.

The first topic, presented as an "application of information theory," was based on an analogy: in the same way that information theory was concerned with the reliable transmission of information over a noisy channel, he wanted to tackle the structure of computing machines in which reliable computing is supposed to be achieved using some unreliable elements, a

problem to which John von Neumann devoted considerable attention. Starting from this parallel, notions such as redundancy and channel capacity were to be used to improve the architecture of computing machines.

The second topic dealt with the way in which a "brain model" can adapt to its environment. This had no direct link with information theory but was more related to the work Shannon had presented during the eighth Macy meeting, in March 1951, where he gathered with other cyberneticians. Shannon demonstrated an electromechanical mouse he called Theseus, which would be "taught" to find its way in a labyrinth. In his Dartmouth proposal, Shannon put the emphasis on "clarifying the environmental model, and representing it as a mathematical structure." He had already noticed that "in discussing mechanized intelligence, we think of machines performing the most advanced human thought activities— proving theorems, writing music, or playing chess." He posited a bottom-up approach in the "direction of these advanced activities," starting with simpler models, as he had done in his 1950 paper entitled "Programming a Computer for Playing Chess." In this first published article on computer chess, Shannon offered the key elements for writing a "program," such as an "evaluation function" or a "minimax procedure."

Claude Shannon with an electronic mouse which has a "super" memory and can learn its way round a maze without a mistake after only one "training" run. (Hulton Archive/Getty Images).

6. A Complex Legacy. Shannon's contributions to artificial intelligence have often been neglected because of the enormous aura. He is so well known for his work on information theory that his credit for AI is often ignored. Most history of AI does not even mention his presence at the Dartmouth meeting of information theory. None of the works he wrote after the 1950s received such recognition. He left Bell Labs for the Massachusetts Institute of Technology (MIT) in 1956, first as a visiting professor; he was a permanent member of the Research Laboratory of Electronics at MIT for twenty years, starting in 1958, after he had spent a year as a fellow at the Center for Advanced Study in the Behavioral Sciences in Palo Alto.

Most of his scientific work was devoted to the promotion and deepening of information theory. Shannon was invited to many countries, including the Soviet Union in 1965. While there, giving a lecture at an engineering conference, he had an opportunity to play a chess match against Mikhail Botvinik. He tackled the case of transmission with a memoryless channel (a noisy channel where the noise acts independently on each symbol transmitted through the channel). It is on this topic that he published his last paper related to information theory, as early as 1967, with Robert G. Gallager and Elwyn R. Berlekamp.

In the late 1960s and 1970s, Shannon became interested in portfolio management and, more generally, investment theory. One of his colleagues at Bell Labs, John L. Kelly, had shown in 1956 how information theory could be applied to gambling. Together with Ed Thorp, Shannon went to Las Vegas to test their ideas. In 1966 they also invented the first wearable computer at MIT that was able to predict roulette wheels.

Shannon never gave up constructing eccentric machines, like the THROBAC (THrifty ROman-numeral BAckward-looking Computer) he built in the 1950s, the rocket-powered Frisbee, or a device that could solve the Rubik's Cube puzzle. He developed many automata, many of which he kept at his home: among others, a tiny stage on which three clowns could juggle with eleven rings, seven balls, and five clubs, all driven by an invisible mechanism of clockwork and rods. Juggling was one of his passions, which also included playing chess, riding a unicycle, and playing to clarinet. In the early 1980s Shannon began writing an article for Scientific American called scientific Aspects of Juggling," which he never finished (Sloane and Wyner, 1993, pp. 850–864).

At the dawn of the twenty-first century, Shannon's contributions are manifold. Whereas there are still applications that only consist of using the logarithmic mean or the schematic diagram of a general communication system (applications he condemned in his 1956 editorial, "The Bandwagon"), there are also numerous new fields that could not be defined without referring to his work. In the field of technology, coding theories that are applied to compact discs or deep-space communication are merely developments of information theory. In mathematics, entire parts of algorithmic complexity theory ($\rightarrow$*Algorithmic Information Theory*) can be seen as resulting from the development of Shannon's theory. In biology, the protean use made of the expression "genetic information" explains the development of molecular biology (Fox Keller, Kay and Yockey). From the 1990s onward, in physics, the domain of "quantum information" took off around the definition of qubits, which extended the bit initially used by Shannon to measure information. Shannon unfortunately could not take part in these developments nor take them into account; from the mid-1990s he struggled with Alzheimer's disease, to which he succumbed in February 2001.

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The master's and PhD essays are also available at the MIT's online institutional repository:

— <http://dspace.mit.edu/handle/1721.1/11173>
— <http://dspace.mit.edu/handle/1721.1/11174>

The 1939 letter was first reproduced in Hagmeyer's doctoral dissertation (see below). Shannon's archives are at the Bell Laboratories Archives and at the National Archives in Washington, DC.

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(JS)

SHANNON´S FUNDAMENTAL THEOREMS (S. *teoremas fundamentals de Shannon*, F. *théorèmes fondamental de Shannon*, G. *Shannon-Grundsätze*) [MTC] theorem

Contents.— *1) Fundamental theorem for a noiseless channel, 2) Fundamental theorem for a discrete channel with noise, 3) Complementarity of both theorems.*

1. Fundamental theorem for a noiseless channel. Let a source have entropy H (bits per symbol) and a channel have a capacity C (bits per second). Then it is possible to encode the output of the source in such a way as to transmit at the average rate C/H–ɛ symbols per second over a channel where ɛ is arbitrary small. It is not possible to transmit at an average rate greater than C/H. (Shannon 1948: 16)

Shannon probes here the existence of a limit to the efficiency of what has been called *source coding* (→*encoder*). If the entropy of a source – characterised by the emission of a finite set of symbols– can be determined, then we know H (in bit/symbol) would correspond to the minimum binary digits to be used for its coding. Any move to this limit translates into a growing complexity (in operational and/or circuital costs). As in other fundamental results of the MTC, it deals with a non constructive conclusion "leaving open the problem of designing codes" (→*Shannon, C.E.*).

In technical practice, source coding is not only attained to the statistical level addressed by Shannon. The most sophisticated techniques of source coding are actually a combination of:

1) *predictive coding*, in which the sender only conveys what cannot be predicted from previous sendings, achieving optimal results if source peculiarities and pragmatic context are analysed in depth (e.g. for the reproduction of a piano playing, keyboard touching is just registered).

2) *Transformational coding* (especially applicable for signals addressed to sensory organs), in which a linear transformation is applied to signals to be conveyed (reversible) enabling to distinguish ranges of different sensibility. This makes possible to leave out data being imperceptible or under certain quality thresholds (operation entailing an irreversible loss of data –not necessarily information, as it is commonly said, if this data is not able in the least to 'inform' recipients). In that coding, efficiency is achieved through an analysis in depth of the sensory perception.

3) *Statistical coding*, in the sense pointed out by the MTC where source emissions are regarded as ergodic and stationary processes.

2. Fundamental theorem for a discrete channel with noise. Let a discrete channel have the capacity C and a discrete source the entropy per second H. If H≤C there exist a coding system such that the output of the source can be transmitted over the channel with an arbitrarily small frequency of errors (or an arbitrary small equivocation). If H>C it is possible to encode the source so that the equivocation is less than H–C+ε where ε is arbitrarily small. There is no method of encoding which gives an equivocation less than H–C. (Shannon 1948: 22)

Since here the source is characterised by its information transmission rate (according to Shannon's definition of entropy), this theorem warns us that the transmission of this information flow requires at least a channel of capacity bigger than H. We might vainly try to transmit it through a channel of lesser capacity, any excess of source entropy with respect to channel capacity will imply a corresponding increase in the rate of error reception. On the other hand, approaching to the threshold (C≈H) leads to an increase in (operational/circuital) complexity.

How can the distance between source entropy H and channel capacity C be employed? Redundancy might be employed in order to facilitate recipients identification and correction of transmission errors. This kind of coding in named channel coding (→*encoder*). There are several techniques to add redundancy, which can be classified in *block codes* and *convolutional codes*. In the former, consecutive data blocks are used to determine the added redundancy; in the convolutional ones, state machines are used, which output depends on the coder state and entry data. Error correction looks in the former for the most similar valid block, in the later for the most similar sequence of valid code.

3. Complementarity of both theorems. Thus, there is a certain practical complementarity between these two theorems: the former indicates how far we can compress the code for conveying source messages (maximally removing redundancy); the second shows us the redundancy the system could use in order to facilitate error correction.

At a glance, source coding tries to equate binary digits to bits, maximizing entropy and

eliminating whatever is non entropic and useless for decoding purposes, whereas channel coding adds non entropic digits that can be recognized by recipients to eliminate transmission errors.

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(JMD)

SIGN (S. *signo*, F. *signe*, G. *Zeichen*) [transdisciplinary, semiotics, communication theory]_{con-}cept

The use frequently given in antiquity to the word *sign*, σημεῖον, corresponds to a signal, usually verbal, through which something is represented. However, it was also used in a number of more technical meanings -sometimes confronted-, such as in the realist and nominalism positions. In modernity, especially among racionalists, a sign tends to refer to ideas. However, in Empiricism, the word sign gains a significant relevancy, distinguishing its suggestive dimension –already pointed out in antiquity and medieval nominalism-. In current times, the most influential trends are perhaps the ones started by *Saussure*, *Peirce* and *Husserl*, being the first two more influential in linguistics, semiotics and anthropology, whereas Husserl's influence was driven by phenomenology and →*hermeneutics* into a wide spectrum of social sciences.

For **Saussure,** the sign (seen from a linguistic point of view) is a non-separable double-faced "psychic entity": the acoustic image (named *signifier* –"significant") and the concept (*signified* –"signifié"), where its bonding link is arbitrary. Structuralism extended Saussure's concept of sign to non verbal phenomena.

Peirce designates as sign "an object which stands for another to some mind". He distinguishes three points of view: 1) as being signs in themselves (dealt with in grammar); 2) as being related with an object (dealt with in logics); 3) as being related to subjects or "interpretants" (dealt with in pure rhetoric). He also distinguishes, depending on the relation with three types of signs: *iconic* (which are significant even if the object does not exist); *indexes* (which loss their constituting character if its object is suppressed, but not if the interpreter is missing); and *symbols* (which loss their constituting character if its interpreter is missing). Structuralism develops an even more elaborated classification, in which these three types pointed out by Peirce reappear, based on the established relationship between significant and signified (arbitrary, metaphoric, metonymic, etc.).

Morris –following Pierce- states that the sign is what supports a triadic relation: with other signs, with designated objects and with the subjects using the sign. *Syntactics*, *semiotics* and *pragmatics* are concerned with the study of each of these relations respectively, whereas *semiotics* or semiology deal with the general study of the sign.

Husserl makes a fundamental distinction between sign and signification, according to which, even though every sign is a sign of something, not all signs have signification, i.e., it does not necessarily comprise a sense being expressed by it. Sometimes, we cannot even say that a sign designates that of which it is called a sign. For Husserl, signs can be *indicative* (limited to indicate, but not to signify) and *significative* (or expressions pointing to a signification, which is one of the elements of the intentional act, usually wider than effectuations or fulfillments, and only matching up such act if a complete adequacy is given between signification and what is signified, the intentional object). With this characterization, a stance is taken up rejecting both the signic arbitrariness of nominalism and the expressive naturalness of realism, clarifying the "ambiguous significative situation".

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(JMD)

SITUATIONAL LOGIC (S. *lógica situacional*, F. *logic situationnel*, G. *situative Logik*) [Situacional Semantics] theory

Situation Theory is an attempt to provide with a mathematical formulation the Situational Semantics developed by Braswise and Perry (1983). Keith Devlin (1991) in Logic and Information dressed the Situation Theory with the mathematical necessary apparatus to be able to treat it from an own, solid and mathematically coherent perspective.

The basic ontology of the Situation Theory forms those organizations that a mental agent, with his limitations, is able to individualize and/or to discriminate. Among the objects, also known as uniformities (or regularities) we found individuals in the situational ontology, relations, locations, temporary locations, situations, types and parameters.

The framework regarding to the agent who gathers the ontology denominates "individualization scheme" (appropriate for the study of the flow of information of an agent). The information always must be information referring to a certain situation, and it takes in the form of well-known discreet items, like "infons". An infon is an object of the form:

$$\langle\langle R, a_1, a_2, \cdots, a_n, 1\rangle\rangle \cdot \langle\langle R, a_1, a_2, \cdots, a_n, 0\rangle\rangle$$

where R denotes a relation among n appropriate objects to describe it and denotes if these objects are in relation or they are not. The last element (1 or 0) is called "polarity" and is the one that shows the veracity if polarity is 1, or falseness if polarity is 0, of the relation R.

In terms of the Situation Theory, infons are semantic objects within the mathematical theory. They are not phrases in some language that require an interpretation. Infons are the minimum units of the information.

Infons can be referred to more than a relation by means of operations of conjunction and disjunction. These infons are labeled "compounds infons", e.g. the one obtained representing the infon that characterizes the shout of the word fire.

$$\langle\langle shout, a, t, 1\rangle\rangle \wedge \langle\langle word, a, FIRE, t, 1\rangle\rangle$$

The infons can include parameters as in the previous example are $\dot{a}$ and $\dot{t}$, in this case of spatial and temporary type respectively. The parameters indicate elements that do not become informational until they are anchored* to a concrete situation.

Given a situation s and an infon σ we wrote:

$$s \sqsubset \sigma$$

in order to indicate that the infon σ is a "factual fact" for the situation s. Expressed in other words, we can say that σ is a information item that is a truth in the situation s. Therefore, from the situational perspective the information is treated like merchandise. Merchandise that, in addition, doesn't have to represent always a "true" value, because for each infon exists its dual negative that can be understood as their opposite informational one and both cannot be "true".

Situations that share common characteristics are gather in Types, giving place to entities of higher-order, situation-types. This one is an abstract concept that gathers elements with common characteristics and always belongs relative to the agent.

Constraints are abstract bonds between types of situations. They can be of diverse types: natural laws, linguistic, empirical conventions,

relations logics, rules, or of any other type. Its paper in the chain of the information is well gathered in Israel and Perry (1990) by the word "meaning".

The constraint between two types T and T' indicates that an element of type t, will carry information of an element of the type t' within the terms determined by the situation that includes them.

In order to be able to construct the meaning, the agent must be able to settle down constraints between each one of the identified situations type, in the context of the situation. The representation of Infon gathering the constraint between two situations type s and s' is the following one:

$$\langle\langle \Rightarrow, s, s', 1 \rangle\rangle$$

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(CA)

SOCIAL WEB (S. *Web social*, F. *Web Social*, G. *Soziales Netzwerk*) [Web, Information Society, ICT] concept, resource

Contents.— *1) History of the term, 2) Semantic Web and Social Web, 3) Social Web and Semantic Web Comparison, 4) Conversion of folksonomies into more complex KOS.*

Social Web is a set of resources and practices that enable the users to socialize with each other. In the literature, Web 2.0 is usually employed as a synonym.

Also Web 2.0 is used to refer to the set of technologies focused on social interaction. Most of these tools are free.

Web 2.0 is a platform, where users are the principal centre of attention; the user decides what to use and how to use it. Applications

such as Flick or YouTube demonstrate the great acceptance and vitality of this platform. The approach is based on the involvement and collaboration of users for the management of resources, using friendly and well designed user interfaces. The architecture of these applications permits to users to describe resources with tags. In contrast to Semantic Web, this approach lacks a central authority to organize and standardize the way that the Web is managed, and hinders progress towards general acceptance by other software developers.

1. History of the term Web 2.0. Dale Dougherty from O'Reilly Media was the person that invented the term Web 2.0 at a conference with Craig Cline from MediaLive. During the speech on the evolution of the Internet they realized the numerous collaborative services that had emerged, as well as the will of the users to share resources. The term was affirmed in the 2004 Web 2.0 Conference; within one year the term Web 2.0 already had 10 millions references in Google, even though its significance remained vague. In contrast with the Semantic Web, its appearance was not in response to a planned and coordinated effort, neither the assumption on behalf of the experts that the Web was evolving autonomously, was suggesting such a proposal.

2. Semantic Web and Social Web. Web 2.0 and Semantic Web (SW) are technologies with a great potential for the network and ultimately, for the final user. Both aim to improving the mechanisms for sharing information and resources. Frequently, Web 2.0 is presented as an intermediate stage to future Web 3.0 (called Semantic Web). Web 2.0 is oriented to persons, while the Semantic Web is oriented to applications; this stems from the fact that the first employs a free language and the latter a controlled language. Web 2.0 attempts to give the users a legible and usable semantic, while the Semantic Web projects the correct interpretation of the semantic for computer applications.

3. Social Web and Semantic Web comparison. To explain why the Social Web is more

popular than the Semantic Web, at the moment, we analyze and compare some characteristics between both webs according to different criteria. Some of them demonstrate that they treat the two concepts with different approaches.

At first glance, it could be assumed that both the Social Web and the Semantic Web could be in conflict. At the same time, though, they could be viewed as two complementary aspects of the Web which, by operating synergistically, could increase the potential of both.

Therefore, after questioning the reason for their mutual existence and why the Social Web has had such success compared with the Semantic Web, it becomes evident that they treat two independent necessities as being equally indispensable.

4. Conversion of folksonomies into more complex KOS. Some Web resources are under analysis for their evolution to KOS complexes, e.g. the folkontologies, which study evolution mechanisms starting from a folksonomy.

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(JML)

SUPER-RECURSIVE KOLMOGOROV COMPLEXITY (S. *complejidad de Kolmogorov super-recursiva*; F. *Complexité de Kolmogorov super-récursif*; G. *Superrekursive Kolmogorow-Komplexität*) [AIT, computer science, complexity theory, coding theory]concept

Contents.— *1) Absolute and relative super-recursive complexity; 2) Inductive Kolmogorov complexity*

1. Absolute and relative super-recursive complexity. Super-recursive Kolmogorov complexity is an algorithmic measure or measure of algorithmic information. It is defined for constructive objects, such as words in some alphabet. If x is a word and **K** is a class of super-recursive algorithms, then, as in the case of recursive algorithms, we have two types of super-recursive Kolmogorov complexity.

The Kolmogorov complexity $C_B(x)$ of an object (word) x with respect to an algorithm B from **K** is defined as

$$C_B(x) = \min \{l(p); \ B(p) = x\}$$

in the case when there is a word p such that $B(p) = x$,
otherwise $C_B(x)$ is not defined.

When **K** has universal algorithms, Burgin (1982, 2005) proved that there is an invariant up to some additive constant super-recursive Kolmogorov complexity $KC(x)$. It is called absolute super-recursive Kolmogorov complexity because there is also relative super-recursive Kolmogorov complexity $KC(x|y)$. Namely, there is an algorithm U such that for any Turing machine T, there is a constant c_{UT} such that for all words x, we have

$$C_U(x) \leq C_T(x) + c_{UT}$$

The machine U is a universal in **K** algorithm. This makes the concept of super-recursive Kolmogorov complexity invariant up to an additive constant if we put $KC(x) = C_U(x)$.

Thus, the super-recursive Kolmogorov complexity $KC(x)$ of a word x is taken to be equal to:

> the size of the shortest program (in number of symbols) for a universal in **K** algorithm U that without additional data, computes the string x and terminates.

This measure is called absolute super-recursive Kolmogorov complexity because super-recursive Kolmogorov complexity has also a relative form $KC(x \mid y)$.

There are many different classes of super-recursive algorithms: limiting recursive functions and limiting partial recursive functions introduced by Gold, trial and error predicates introduced by Hilary Putnam, inductive Turing machines of different orders and limit Turing machines of different orders introduced by Burgin, trial-and-error machines introduced by Hintikka and Mutanen, general Turing machines introduced by Schmidhuber, etc. Each of these classes defines its own super-recursive Kolmogorov complexity.

2. Inductive Kolmogorov Complexity. Inductive Turing machines form the class of super-recursive algorithms closest to the conventional classes of algorithms, such as the class of all Turing machines. As a result, the closest to the conventional (recursive) Kolmogorov complexity $C(x)$ is inductive Kolmogorov complexity $IC(x)$. If x is a word, then the original Kolmogorov complexity $IC(x)$ of a word x is taken to be equal to

> the size of the shortest program (in number of symbols) for a universal inductive Turing machine of the first order U that without additional data, computes the string x.

This measure is called **absolute inductive Kolmogorov complexity** because inductive Kolmogorov complexity has also a relative form $IC(x \mid y)$. Namely, the **relative inductive Kolmogorov complexity** $IC(x \mid y)$ of the word x relative to the word y is taken to be equal to:

the size of the shortest program (in number of symbols) for a universal inductive Turing machine U that with y as its input, computes the string x and terminates.

The inductive relative Kolmogorov complexity $IC(x \mid y)$ allows one to find the algorithmic quantity $IC(y ; x)$ of **inductive information in a word** y **about a word** x, i.e., information that can be extracted by inductive algorithms. Namely, we have

$$IC(y ; x) = C(x) - C(x \mid y)$$

The **inductive Kolmogorov complexity** of an object (word) x **with respect to an inductive Turing machine** T is defined as

> $IC_T(x) = \min \{ l(p); T(p) = x\}$
> in the case when there is a word p such that $T(p) = x$;
> otherwise $IC_T(x)$ is not defined.

Burgin (1990; 1995) proved that there is an **invariant inductive Kolmogorov complexity** $IC(x)$. Namely, there is an inductive Turing machine U such that for any inductive Turing machine T, there is a constant c_T such that for all words x, we have

$$IC_U(x) \leq IC_T(x) + c_T$$

The machine U is a universal inductive Turing machine. This makes the concept of inductive Kolmogorov complexity invariant up to an additive constant.

It is proved (Burgin, 2005) that inductive Kolmogorov complexity for a word x is usually much less than recursive (conventional) Kolmogorov complexity for the same word. It means that to build a constructive object, e.g., a word, it is necessary to have much less inductive algorithmic information than recursive algorithmic information.

At the same time, many properties of inductive Kolmogorov complexity are similar to the properties of the conventional Kolmogorov complexity For instance, when the length of a word tends to infinity, its inductive Kolmogorov complexity also tends to infinity.

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(MB)

SYSTEM (S. *sistema*; F. *système*; G. *System*) [transdiciplinary, system theory] concept

The idea of viewing reality as a whole, or as a series of interconnected structures or systems, is perhaps as old as mankind. And it appears to be deeply rooted in our ordinary knowledge.

The history of ideas has left us an amount of problems closely related to the notion of system (for example, the relationship between the whole and its parts, or the relationship between the causes and the goals). Nowadays, Bertalanffy, Wiener, Thom, Prigogine, Mandelbrot... have highlighted the need for a systems approach in science. Bertalanffy is well known as the creator of the Theory of Systems. A system is defined as a complex object of interacting elements. Given some conditions, an element will behave in a certain way. When these conditions change, the behaviour will also change. Bertalanffy thinks the main characteristic of a system is that the whole contributes more tan the separate parts, taken in isolation, due to interactions among them.

The meaning of the term "system" is not unambiguous, but each author seems to give a different meaning. That is why different formalizations have been proposed (Klir, Bunge, Zeigler...). These formalizations help to clarify many of the intuitive notions about the relationships between systems and their environment, about the distinction between natural and artificial systems, about the structural complexity of the systems, about the relationships between systems and their models, etc.

The concept of system goes usually associated with the concepts of model and simulation. A meaning of the term model is that of a simulated system. There are different systems modelling techniques (for example, System Dynamics).

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(MV)

SYSTEM THEORY (S. *teoría de sistema*; F. *Théorie des Systèmes*; G. *Systemstheorie*) [transdiciplinary] theory

Systems theory (ST) is a specific way of how to reflect the totality of material or mental objects, their structures, their quantitative and qualitative change and their relations to their environment. It represents the structured portraying, designing, reifying and interpreting of this totality. By portraying ST picks up certain essential aspects of perceived reality; by designing ST (re)constructs this totality in a certain way; by reifying it transforms the mental image into scientific language and/or into mathematical expressions; by interpreting ST links the totality to the philosophical, political or scientific context.

ST deals with the relations between structure, function and dynamics of a system, with the relations between its elements or parts and the total system, with the relations between the system and its environment, and with the identification and classification of systems.

The vibrant development of the productive forces in the last century based on scientific revolutions provides the basis for a deepened understanding of totalities. At the same time,

extreme specialization of science and research generates a growing need for ST to handle complex practical problems of contemporary life.

Although systems thinking can be traced back to ancient Egypt, ST as an area of study was developed by the works of Ludwig von Bertalanffy, William Ross Ashby, Gregory Bateson, Kenneth E. Boulding, C. West Churchman, Heinz von Förster, Paul Lazarsfeld, Kurt Lewin, Warren McCulloch, John von Neumann, Margaret Mead, Anatol Rapoport, Norbert Wiener and others in the 1950s. Between 1946 and 1953 ST was specifically catalyzed by the Society for General Systems Research and the Macy Conferences (organized in the US by the Josiah Macy, Jr. Foundation).

Specific versions of Systems Theories exist in cybernetics and in the theory of adaptive systems. Applications can be found in mathematics and computing (control theory), system dynamics (Jay Forrester), agent based modeling, systems engineering, biochemistry, theories of living systems, anthropology, sociology and social cybernetics, economics, ecology, political sciences, history, archeology, systems psychology, group dynamics and theories of organization etc.

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(PF)

T

TAXONOMY (S. *taxonomía*, F. *Taxinomie*, G. *Taxonomie*) [Knowledge Management, Knowledge organization, semiotics] concept

Taxonomy is a classification or categorization of a set of objects in a hierarchical way. A generic-specific relationship is established between pairs of terms. This hierarchical arrangement is present in every Knowledge Organization System (SKOS): thesaurus, concept model, or ontology.

The main components of taxonomies are:

— *Hierarchical structure* (specific context) with different levels of specificity.

— *Labels* (names that label each concept). They are the elements in the structure, grouped in thematic sets.

— *Faceted.* Every concept might belong to a different facet. These facets enable handling sets of terms grouped by attributes. This approach facilitates indexing and retrieval tasks.

Taxonomies are used in companies and organizations to manage and organize their information resources. This facilitates searching, browsing and navigation in the hierarchy. Some applications allow:

1) Arrangement of the company vocabulary in domains that are not important enough to have their own public controlled vocabulary.

2) Representation of the terms that the organization employs every day.

3) Completion of terms with definitions about their specific use.

4) User orientation.

5) Navigation through the hierarchical structure.

6) Specification of the query, thus narrowing the used terms.

7) Organisation on internal business needs. Users arrange terms in a meaningful way.

8) Development and updating of the structure, according to changing business requirements.

Taxonomy organizes not only the vocabulary of an organization, but also its output and resources, including its know-how. Taxonomies inherit the hierarchical classification from SKOS and the descriptors from the thesaurus. They are used to organize large amounts of data, with the help of a controlled vocabulary.

In short, taxonomy arranges its hierarchical structure in accordance with a context and a group of users. This resource merges an indexing language with a specific vocabulary, reflecting in its structure both the domain and information needs of an organization.

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(JAM)

TEMPORAL LOGIC (S. *lógica temporal*, F. *taxonomie*, G. *taxonomie*) [logic] concepto

Ever since Aristotle (and even before him, see the stoics), philosophers have tried to formalize time. It is only around the fifties, starting with the work of Arthur Prior, when temporal logic is developed considerably with the development of new systems used to represent different types of time (linear time, infinite time, branching time, etc.). The foundation of possible worlds semantics was vital for the semantics of such systems. These systems have found applications in a variety of fields, the most representative being those of linguistics and computer science.

Temporal logic systems can be based on propositional logic or on first order logic. On both cases operators are added to represent the past (P and H) and the future (F and G). It is also possible to include operators to represent intervals. The most common semantics is based on the notion of moment. These moments are organized through an ulteriority relation (before/after). Hence, if I claim that $m_0 < m_1$ I am claiming that moment m_0 is previous to moment m_1. This ulteriority relation has different properties depending on the type of time we are working with, although it is always irreflexive. Thus, for instance, if time is transitive, the ulteriority relation will have the transitive property and syntactically transitivity axioms will be introduced (FFA→FA and PPA→PA).

There are multimodal and bidimensional systems of temporal logic, such as the system of indeterministic time HN1, which combines temporal and modal operators and in whose semantic, evaluation is made in two indices (moment and history).

Presently, hybrid temporal logic systems are being developed. These systems increase the expressive power of temporal logic, because they allow making reference in the syntax to the moments.

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(MV)

THESAURUS (S. *tesauro*, F. *thésaurus*, G. *thesaurus*) [Information retrieval] concept

Contents.— *1) Thesaurus elements, 2) Thesaurus features, 3) Differences between Ontologies and Thesauri, 4) Methodologies to build Thesauri, 5) Some Thesauri online, 6) Software to edit and manage Thesauri, 7) Standards*

A thesaurus is a controlled vocabulary used to represent the concepts of a specific domain systematically. The thesaurus identifies the relationships between concepts. Every concept is represented by a single term, called a descriptor. Thesauri are resources developed to index documents by these descriptors.

1. Thesaurus elements. The thesaurus consists of:

Descriptors: normalized terms. Descriptors represent a relevant concept in the domain.

Non-descriptor: Some descriptors might have an equivalent term, called a non-descriptor. A non-descriptor can only address one descriptor in the thesaurus. These terms represent an equivalence relationship with a single descriptor in the domain; they could be used to expand the query.

Hierarchical relationships: they represent the relation between a generic concept and a specific concept. This relationship includes: Broader-Narrower Concepts; Genus-Species; Whole-Parts; and Class-Instances. Polyhierarchies, a

specific concept with two or more generic concepts are allowed

Associative relationship: This is a relationship to link concepts semantically. It is used when there is no hierarchical or equivalence relation

Scope notes: This is an explanatory note about the scope and utilization of a descriptor.

Example:

CAR

BT	automotive vehicle
NT	ambulance
NT	cab
RT	driver
RT	road
UF	automobile
SN	Regarding part of a train, see railcar

where BT stands for Broader Term; NT Narrower Term; RT Related Term; UF Use For; and SN Scope Note

2. Thesaurus features

Domain coverage. Some thesauri are multidisciplinary; others just cover a specific domain. Multidisciplinary contexts increase the ambiguity. This is due to a higher probability of polysemes and homonyms.

Output formats: Usually, a thesaurus layout has two output formats on paper: alphabetic and systematic (hierarchical). The rise of the web has produced an increase in web formats, XML or RDF, both with the metadata vocabulary SKOS. Other vocabularies have been proposed like Zthes, BS8723, MADS, or Topic Maps' PSI.

Monolingual/Multilingual: Multilingual contexts have the same problems as multidisciplinary context.

Polyhierarchies/Monohierarchies: problems with polyhierarchies are due to query expansion in a random way.

Uniterms/Compound terms. Compound terms are usually nouns, but some thesauri have adjectives (as part of compound terms), acronyms, verbs and proper nouns.

3. Differences between Ontologies and Thesauri.
The thesaurus has a few predefined elements. It has a lexical nature, and its main applications are in natural language. The origin of the thesaurus was on paper, nowadays the thesaurus has moved to digital media. This implies the codification of thesauri using web languages, like RDF or XML, and expressing thesaurus elements with metadata vocabularies, like SKOS.

Ontology has a semantic nature. Its origin was in philosophy, logical mathematics and artificial intelligence. It enables inference by a set of rules, axioms, and restrictions. The current success of ontologies is due to their presence in the Semantic Web. In this context, they provide a necessary way to share knowledge on the Web. One of the main concerns is interoperability, which is a property that ensures that unknown software will be able to work with ontologies all over the Web. Interoperability needs to represent knowledge in a formalized way, like RDF or OWL. Primitives of ontologies are properties (slots), instances, hierarchies, and relationships.

An important difference with ontologies is that thesauri are built to facilitate an existing information need. Ontologies have a proactive origin. They are often built before the need arises.

Both, ontologies and thesauri, represent the main concepts of a domain, and its relationships. Methodologies to build ontologies and thesauri share their first steps, but the higher semantic and logic load nature of ontologies divides later stages in their respective developments. In the ontology literature, thesauri are called light ontologies. Building ontologies is a laborious task, and to work with a natural language thesaurus represents a more efficient and simple approach.

4. Methodologies to build thesaurus

1) Firstly, identify the information needs that the thesaurus will satisfy and the domain to be covered.

2) Next, similar thesauri and resources must be analyzed to see if they can be utilized.

3) Select software to edit and codify the thesaurus. User interfaces to manage and query must be as intuitive and friendly as possible.

4) Main terms must be selected. Typically, resources needed to identify these terms are domain experts or specialized literature.

5) Define a small number of seed terms in the thesaurus. Usually, around 10 is enough.

6) Terms must be arranged in a hierarchical way. Usually, new terms are included to avoid gaps in the hierarchical structure.

7) Relationships between concepts must be defined.

8) Train Indexers to use the thesaurus.

9) Maintain, update and improve the thesaurus.

5. Some thesaurus online

Agrovoc: multilingual thesaurus developed by FAO and focused on agriculture. It has an equivalent thesaurus in NALT.

CAB Thesaurus: focused on life sciences

Canadian literacy thesaurus: literature thesaurus, bilingual.

Eurovoc: multilingual thesaurus, developed by EU to manage administrative documents

Mesh: Medical Subject Headings, one of the largest, centered on the medical domain and used to index the Medline database.

Wordnet: lexical database, centered on the English language. There are other versions in other languages. It is widely used in ontology construction, word sense disambiguation (WSD), merging, retrieval, translation, and other Natural Language Processing (NLP) applications.

6. Software to edit and manage thesauri:

TCS: thorough and flexible software. It has suitable features to adapt thesauri to the Web. It has a good set of export formats

Domain Reuse: This suite has some tools to perform term filtering and to identify relationships between terms.

TemaTres: A free platform to edit and manage thesauri on the Web. It can export to several Web formats and use different metadata vocabularies.

ThManager: a tool to edit and manage thesauri, free, and multilingual. It exports with Dublin Core and SKOS formats. This software can extract terms with WordNet.

7. Standards

ISO 2788 (1986) Guidelines for the Establishment and Development of Monolingual Thesauri.

Z39.19 (2005) Guidelines for the Construction, Format, and Management of Monolingual Thesauri

ISO 5964 (1985) Guidelines for the Establishment and Development of Multilingual Thesauri. It is one of the first standards to talk about the alignment problems.

ISO 13250 (2003) Topic Maps, were developed to merge index of words, and its Published Subject Indicators (PSIs) about thesauri are strongly related to the SKOS proposal.

Related Resources:

— Cab thesaurus. [Online] <http://www.cabi.org/> [Consulted 1/7/2009]
— Canadian literacy thesaurus. [Online] <http://www.thesaurusalpha.org/> [Consulted 1/7/2009]
— Domain Reuse. [Online] <http://www.re-usecompany.com/validaProducto.aspx?id=13&demo=1> [Consulted 1/7/2009]
— TCS-10 [Online] <http://www.web-choir.com/products/tcs10.html> [Consulted 1/11/2009]
— Thmanager. [Online] <http://thmanager.sourceforge.net> [Consulted 1/7/2009]
— Tematres [Online] <http://tematres.r020.com.ar/index.en.html> [Consulted 1/11/2009]

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(SSC –ed.-; EC, JML)

TOPIC MAPS (S. *mapas conceptuales* F. *schéma conceptuel*, G. *Begriffslandkarte*) [Praxis, e-learning, Technical communication] concept

Contents.— *1) Standards related to Concept Maps, 2) Related proposals, 3) Concept map editors.*

A concept map is a graphic resource to represent the knowledge within a specific context. Originally, it is a learning resource to improve understanding about a process, subject or topic (Novak). Concept maps have a set of labeled nodes, linked among them. These links might be labeled, to improve the understanding of the graph. Neither, the graphical representation nor the types of relationships are standardized.

1. Standards related to Concept Maps

Topic Maps: The standard Topic Map (ISO 13250:2003) is a scheme to formalize the representation of concepts and relationships of a domain. Concepts (called "topics") are related (by "associations"), and referenced to information resources ("occurrences"). TopicMaps is part of the Semantic Web. These maps are expressed in XML to improve intereroperability. Despite the name, graphic representation is not the main concern of this standard.

UML and Entity Relationships Diagrams: UML stands for Unified Modeling Language, together with Entity Relationship Diagrams, it is the most popular graphical resource in Software Engineering. Their combined goal is to improve the communication between non technical clients and software developers. There are several types of diagrams: 1) Structural Diagrams: Class diagrams, components diagrams, object diagrams, deployment diagrams, and package diagrams. 2) Behavior information is represented by: activity diagrams, state diagrams; 3) Interaction Diagrams are represented by sequence diagrams. UML is supported by the Object Management Group (OMG). When compared with ontologies, a particular strength is that it is possible to specify activities and processes in a way that is understood by both software developers and their clients.

2. Related Proposals

Semantic Networks: This is a network showing semantic relationships. The main difference from concept maps is the origin. Concept maps were developed with a pedagogical goal, emphasizing graphical understanding; semantic networks had their oringins in computer engineering and artificial intelligence, stressing process like inference and codification. So the edges of semantic networks are usually labeled with weights. These weights express the closeness between the nodes.

Mind Maps or memories: This is a type of concept map centered on a single node/concept. Related concepts or ideas are linked with this central node, in a shape similar to a star (radial hierarchies or tree structures). Brain storming sessions usually express the outputs with mind maps.

Social Networks: This is a type of semantic network, where the nodes are individuals or organizations. The Erdős number (also

known as the Bacon number) is one of its metrics. This number computes the coauthorship distance between the mathematician Erdős and another author. Other measures are centrality and cohesion.

Web Concept Navigation: Navigation by web links is one of the most important developments of concept maps. This topic is taken into account when planning the site architecture and is quite close to the Topic Maps Standard.

3. Concept maps editors

Most of these editors enable the linking of several graphic resources (images, emoticons, shapes …).

— **DigiDocMap**: free tool developed by Pompeu Fabra University
— **CMapTools**: developed by the Institute for Human and machine cognition (University of West Florida). It has functionalities to merge concept maps and to export to the Topic Maps standard.
— **Mindman**: Allows accessing simultaneously several users to the same map.
— **Inspiration**

Resources

— DigiDoc Map (Online) <http://www.mapasconceptuales.com> [Consulted: 1/9/2009]
— CMapTools (Online) <http://www.cmaptools.com> [Consulted: 1/9/2009]
— Mindman (Online) <http://www.mindman.com> [Consulted: 1/9/2009]
— Inspiration (Online) <http://cf.inspiration.com/espanol/ index.cfm> [Consulted: 1/9/2009]

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(JML)

TRUTH VALUE (S. *valor de verdad*, F. *valeur de vérité*, G. *Wahrheitswert*) [semantics, epistemology, knowledge theory] concept

Successful propositional representations express conditions on the world that may or may not be satisfied by it. If they are satisfied, we say the representations are true. If not, we say they are false. Failed propositional representations may not express any condition on the world and, thus, lack truth-value.

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(MC)

TURING'S HALTING THEOREM (S. *teorema de parada de Turing*, F. Indecibilité de l'arrêt, G. *Unentscheidbarkeit von Turings Halteproblem*) [Logic, computability] theorem, concept

Contents.— *1) Basic idea, 2) Concepts, 3) Proofs.*

1. Basic idea. Many problems around us in ordinary life do not seem to have a computational solution. More interestingly, some precisely formulated theoretical and scientific problems are also seemingly insoluble in computational terms. By "computable" we shall understand here computable in its standard sense, that is, able to be solved by the finite, precise and recursive means of any Turing Machine.

However, it is indeed surprising and theoretically highly interesting that certain arithmetically formulated problems are insoluble by any

standard computation. Imagine we introduce arbitrary finite sequences in a system under the following rules: (1) answer "yes" if the sequence codes a program which terminates, (2) answer "no" if it doesn't (does not codify a programm or does not terminate).This is Turing's Halting problem, for which he proofed the inexistence of any algorithmical decision procedure. The interest of this undecidability result lies in the purely logical reasons supporting it and exporting its uncomputability results to any procedure able to answer it. Moreover, Rice generalizes and extends Turing's results for any non-trivial property of partial functions.

It is important to notice that this and other limitative results from logic, such as incompleteness, do not teach us that we are able to proof results that are beyond any computer. We can, but this is not surprising, belief them.

2. Concepts. The general notion of computation is usually made precise by means of the concept of recursion. Church's Thesis states that all computable functions are recursive. Under this asumption, all computable funcions are definable in a fragment of the language of formal arithmetic, or, equivalently, by means of Turing's Machine Algorithms.

In this way, to each program or computation M corresponds a natural number n which is its code or index Mn. The result of introducing an input k in the machine M, gives as a result a sequence M(k). Since computation languages are themselves sequences, they apply to themselves, just as a calculation can be applied over its own code (Mm(m)). This is the source ot may fruitful applications and also of some crucial limitations of computability.

A set is recursively enumerable whenever it is definable in the language RE of formal first order Arithmetic (basicly the standard language of formal arithmetic without negation and with bounded cuantificación). Equivalently, we call a language recursively enumerable if it contains all finite sequences codifying a Turing machine and an input, so that the machine stops at that input. A set (or a problem,

or a language) is recursive if and only if both itself and its complement are recursively enumerable.

For example, consider the problem TERMINATES, posing the task of determining, given a program with code m and an input n for it, if the program terminates or not at n. The problem TERMINATES(m,n) is recursively enumerable, since there is a program accepting TERMINATES, that is, a program terminating whenever its input is in TERMINATES, and not doing it in any contrary case. A program computing TERMINATES terminates at some input n.

Let us now consider the complement NONTERMINATES of the problem TERMINATES. If there is a program for it, it will terminate if its input is in NONTERMINATES, and in any contrary case it won't terminate. As we shall see, NONTERMINATES is not recursively enumerable, and hence TERMINATES is not recursive. This is, informally summarized, the course of the following argument.

3. Proofs

Enumeration Theorem. There is a dyadic relation $T(x,y)$ which is recursively enumerable and recursively enumerates all recursive enumerable sets. That is, for any recursively enumerable set C there is a code e such that $C=\{n:T(e,n)\}$.

Proof. Let Re be the set $\{x:T(e,x)\}$. Te is recursively enumerable, since both T and e are definable in the language RE. Now, C being bt hypothesis also enumerable recursive, it is defined by a formula in a free variable x. Let e be the code or Gödel number of such formula. Hence, $C=Te$.

Certain "diagonal" theorem. The diagonal relation is not computable (recursive).

Proof. Let K be the set $\{x:T(x,x)\}$. K is recursively enumerable, but its complement $-K$ it's not. If it were, $-K=Te$ for some e. But for all x, by the definition of complement, x belongs to $-K$ if and only if x does not belong to Tx.

In the particular case of e, we have e belongs to −K if and only if e does not belong to Te, that is, e does not belong to −K, which is a classical contradiction.

Halting Theorem. TERMINATES is not computable (recursive).

Proof. Suppose for reductio that the two argument function t (m,n) were computable being t(m,n)=1 or =0 depending on whether the machine m with n as input terminates or not. Under this assumption, the diagonal function t(n,n)=t'(n) is also computable, which is impossible by the previous diagonal theorem.

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(FS)

U

UNIFIED THEORY OF INFORMATION (UTI) (S. *Teoría Unificada de la Información*, F. *Théorie Unifiée de l'Information*, G. *Vereinheitlichte Theorie der Information*) [Research and practice] theory

Although the Anglo-Saxon term was used by Kerns Powers (1956) "to provide a unified mathematical theory for the treatment of the statistical processes by which information is conveyed in communication systems", it is now used in a more ambitious proposal that in contrast to Power is not limited to the syntactical level. The UTI aims at a theoretical articulation embracing all processes and structures related to the creation, transformation and the crystallizing out of information in cognitive, communicative and cooperative contexts, by means of (a supposedly feasible) blending of the concepts of self-organization and semiosis (*self-re-structuring*, *self-reproduction*, *self-re-creation*).

The purpose of achieving a comprehensive theory is to enable society to cope with the challenges of the so-called information society. A transdisciplinary development is pursued – nourished by notions developed in the cross-disciplines of informatics, cybernetics, systemics and evolutionary theory, as well as in disciplines of life sciences, psychology, and social and human sciences like semiotics. This approach has been advanced by Peter Fleissner, Wolfgang Hofkirchner, Norbert Fenzl, Gottfried Stockinger and Christian Fuchs. They did so by taking up, while modifying, positions of Michael Conrad, Pedro Marijuán, Koichiro Matsuno, Tom Stonier, Søren Brier, John Collier, Dail Doucette, and others. Most

of the scholars named above have been contributing to the building up of a new *Science of Information*, though they might differ in the feasibility of a unified theory (Capurro et al. 1999, Hofkirchner 2008, Marijuán 2008).

Capurro and Hjørland (2003) criticize this approach as having a metaphysical rather than a scientific status insofar as "a view of the whole of reality that is not possible for a finite observer" is assumed.

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(WH –ed.-; JMD, WH)

USABILITY (S. *usabilidad*, F. *utilisabilité*, *usabilité*, G. *Benutzerfreundlichkeit*, *Benutzungsfreundlichkeit*) [Engineering, Information management, ICTs] concept, discipline

Usability is a discipline whose primary goal is to be involved in the design of objects and resources in order to make them more convenient and easy to use.

In the context of software and web pages, the term "usability" is used to describe the discipline concerned with controlling how easily a digital resource can be used; that is to say, it assesses how this resource facilitates or hinders the use of it.

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(MPM –ed.-; MPM, MG)

V

VIRTUAL (E. *vitrual*, F. *virtual(elle)*, A. *virtuell*) [transdisciplinary, semantics, epistemology]_{con-}cept

If we look up "virtual" on the dictionary we will find: "1. Existing or resulting in essence or effect though not in actual fact, form, or name: the virtual extinction of the buffalo. 2. Existing in the mind, especially as a product of the imagination. Used in literary criticism of a text. 3. Computer Science Created, simulated, or carried on by means of a computer or computer network: virtual conversations in a chatroom."

So we understand virtual as potentiality, ability to be. Things experienced as they could possibly be. Something absurd can never be virtual. To be considered as virtual, something has to be plausible in experience. It is similar to the case of perceptual illusions, even when it is explained to us that something is a perceptual illusion, we cannot help perceiving it (the opposite occurs with, for instance, logical fallacies). Moreover, with regard to the virtual, even though we know it is a fiction, it is not possible to avoid the feeling of reality.

Virtual is a special type of simulation. The difference between the virtual and other types of simulations can be located on the way of perceiving what we experience. Whereas with a simulation model, one is normally aware that one is presenting hypotheses and checking what happens with them, thinking of different scenarios to choose a line of action, with the virtual one normally tries to live experiences in a new scenario (like in the case of games, now so popular, involving virtual life). The problem is whether these experiences are lived as real or not. Do we have the same perception of what is lived when simulating a model than when experimenting with virtual realities?

Virtual can also be interpreted as having some sort of misleading element, for instance, assumed reconstructions of the past or future predictions that are said to be inevitable. It is a case of virtual reality when, in order for a city to obtain the UNESCO world heritage recognition, it is not enough to have beautiful streets or well kept houses, but rather it is required that it has an idea behind it. Things like being designed according to the mentality of the Enlightment could be enough and so, the past is reconstructed so that it becomes suitable. It is enough for the idea to be believable, and if it is indeed the case, most people will end up believing it (regardless of whether it is true or not). Recently television ("National Geographic" and others), is full of documentaries where the past and the future are reconstructed. We see programs about evolution made with amazing techniques or investigation programs about the murder of some Egyptian emperor. When we see them, we get the impression of watching something real, of seeing the truth about things. Even though we know there is not enough information to know what really happened, we believe what they tell us, these programs are appealing, because they tell us the story on an entertaining and didactical way. Also, it is announced on the news that we can now see the real face of Jesus Christ (or Nefertiti) and they show it to us, but if we listen closely we realize it is a mere reconstruction from the heads of people from the same age and time. As if they could not be different from their kind. In some cases, like when predicting facts about the future

through a series of data, we do not have images. It would seem that without images we cannot have virtual reality. I do not think so. I believe that what is characteristic about the virtual is the perception from the user of that as real. If a series of fictional data is perceived as real, then it is up to a certain extent a virtual reality.

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