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# Unified Theory of Information, hypertextuality and levels of reality

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## Abstract

*Purpose* – The different senses of the term information in physical, biological and social interpretations, and the possibility of connections between them, are addressed. Special attention is paid to Hofkirchner's Unified Theory of Information (UTI), proposing an integrated view in which the notion of information gets additional properties as one moves from the physical to the biological and the social realms. The paper aims to discuss these issues.

*Design/methodology/approach* – UTI is compared to other views of information, especially to two theories complementing several ideas of it: the theory of the hypertextual documental universe ("docuverse") and the theory of integrative levels of reality. Two alternative applications of the complex of these three theories are discussed: a pragmatical, hermeneutic one, and a more ambitious realist, ontological one. The latter can be extended until considering information ("bit") together with matter-energy ("it") as a fundamental element in the world. Problems and opportunities with each view are discussed.

*Findings* – It is found that the common ground for all three theories is an evolutionary approach, paying attention to the phylogenetic connections between the different meanings of information.

*Research limitations/implications* – Other theories of information, like Leontiev's, are not discussed as not especially related to the focus of the approach.

*Originality/value* – The paper builds on previously unnoticed affinities between different families of information-related theories, showing how each of them can provide fruitful complements to the other ones in clarifying the nature of information.

### 1. Introduction: is information one or multiple?

The notion of *information* permeates most contemporary culture. Still, it lacks any precise definition accepted by the specialists of all involved domains, hence holding in any research context. Telecommunication engineers measuring entropy and redundancy of information transmitted through a material channel; computer scientists comparing the information processing capabilities of different computers; biologists trying to decipher information contained in DNA of living organisms, and palaeontologists trying to obtain it from the fossil record; linguists studying how information exchanged between humans can be structured; historians using any kind of information to reconstruct our past; journalists reporting factual information; librarians helping their users to find and evaluate the information they need: are they really all speaking about the same entity? Or would it be better at least to distinguish, as proposed by Buckland (2012), between "information-as-thing" (the documents), "information-as-process" (learning) and "information-as-knowledge" (what was learned)?

More generally, does it make sense to speak about information as something actually existing also in inanimate nature, or are we dealing with a phenomenon only associated with a living organism capable of perceiving, understanding, producing and spreading it in a voluntary way? Can information be managed and studied only when instantiated in stable and shareable *documents*, or can it also be chased inside social and business organizations, in the twists and turns of central and peripheral nervous systems, or even in that mysterious, immaterial entity we call consciousness?...

Among the multiple attempts to answer such difficult questions (for surveys see Capurro and Hjørland, 2003, and Salarelli, 2012), we find Wolfgang Hofkirchner's "Unified Theory of Information" (UTI), as developed in several texts and conferences starting from a mid-Nineties paper (Fleissner and Hofkirchner, 1996) till a recent booklet (Hofkirchner, 2010), to be simple, clear and explicatory enough to look convincing and worth to be investigated.

As we aim to show in the next sections, several ideas in this theory agree, or at least are compatible, with two more independent theoretical views on information and knowledge: that identifying the whole world with a universe of hypertextual "documents", and that acknowledging a series of integrative levels of increasing organization as a basic structure of reality, or at least of knowledge of reality as attainable by humans. The main aim of this contribution is to show how these three theories reinforce each other, and how the complex of them can lead to positive fallouts in the philosophy of information, the philosophy of classification, and the philosophy of knowledge.

More in general, we believe that any effort towards conceptual clarification of the types of information, and towards their integration into a single – although articulate – conceptual framework can benefit research, teaching, and professional practices in the information and documentation field. This, indeed, can be achieved by providing new connections between disciplines, theories, lexica, professions, associations and curricula that are currently too often divided and isolated.

## 2. The Unified Theory of Information

The preliminary difficulty of any general theory concerning information lies in having to choose between three alternatives, none of which looks fully satisfying (Capurro, 2009: 134):

(a) erring through univocity, by reducing any kind of information to the simplest one, that is, to the mere existence of something that makes a material entity different from another, like for example colour making the balls in a bag different. This, indeed, leads to a form of reductionism, unable to convincingly account for more sophisticated phenomena, like biological information carried in DNA or semantic information carried in human documents (Floridi, 2010);

(b) applying analogical reasoning improperly, by ascribing properties specific to human communication processes to any kind of information, for example by interpreting tree growth rings, sequences of geological layers, or amount of cholesterol in blood as "messages" having a sender and an addressee. This clearly entails erring by anthropocentric fallacy;

(c) erring through equivocity, by considering the various kinds of information as fully independent entities, that can only be studied by different disciplines. This prevents the very possibility of any unitary science of information.

Authors of UTI believe that their theory is able to avoid this trilemma. Indeed, it opposes both the reductionism of views always tending to reduce the new to the old and the whole to its parts, and the holism of views that, conversely, reject any connection between old and new and between parts and whole (Fleissner and Hofkirchner, 1996: 244).

The key idea allowing for such overcome is evolution, taken in a Darwinian sense as a blind, unplanned sequence of events, including mechanisms of selection of what has got greater survival probabilities, operating for long times on a large number of combinatorial variables, thus *sometimes* making more complex entities develop from simpler entities (Dawkins, 1986). Indeed, in a restlessly, necessarily dynamic universe, any entity that can be modelled as a system of relations between elements (or "nodes"), thus forming nets, undergo a process that is evolutionary:

> "Evolving entities are dynamical **elements**, dynamical **systems** made up of elements and their relations, and dynamical **nets** made up of systems and their relations. [Starting from an undifferentiated net of entities of any kind, it can happen that] "some nodes start making stronger connections with each other than with the remaining nodes, thus forming a coherent relationship, converging, making links with other nodes only via each other and not directly, then they are building a system in which they are the system elements, and their interconnections are the elementary system relations. The remaining nodes and links become the system environment, which comes into contact with the element nodes only via the system" (Fleissner and Hofkirchner, 1996: 245).

In this way, from the net and inside it, some systems evolutionarily emerge that, although not being "other" from the net itself, cannot be fully reduced to the old nodes and links: essentially they are a new way in which the net has organized itself, under the pressures of environmental changes, so as fitting the new situation better. In this perspective, advancement towards more "coherent relationships" should be viewed not as a climb towards any pre-established goal, but only as a gradual series of arrangements, producing configurations more and more stable, durable, and successful in resisting natural disintegration trends induced by the environment. Such aggregation process does not necessarily involve all the available elements (e.g. not all oxygen atoms become part of a living organism), nor it necessarily produces very complex entities (e.g. the most widespread group of organisms still by far is bacteria, having existed for billions of years without any major structural change, as they have reached a remarkable degree of success in their enviroment, and keep it). The evolutionary process simply is the engine capable of explaining the rise of more complex structures – when this occurs –, without need of postulating external interventions in nature.

In such evolutionary dynamics, three levels can be identified:

(1) the micro-level, pertaining to how the *elements* of a system are connected with each other in forming its structure (or organization);

(2) the meso-level, pertaining to the structure and properties of the *system* as a whole;

(3) the macro-level, pertaining to how each system interacts with its environment, connecting with the other systems with which it forms a *net*.

According to UTI, each of these levels corresponds to one of the three main stages that information systems can reach:

(1) at a merely physical level (Hofkirchner, 2010: 85-87), information is only syntactical, as it simply consists of relations between elements. This is what happens with the coloured balls, that can accidentally arrange themselves in the bag in many different ways, without any ordering will, nor any code making their order meaningful to someone;

(2) at the biological level (p. 89-92), the semantic properties of information emerge. These can be coded and decoded by living beings (think of DNA genetic code, or bee dance communicating information on food position) in order to enhance their survival probabilities;

(3) at the level of human society (p. 95-97), we see the addition of properties typical of cultural and normative systems. Hofkirchner calls them "pragmatic" as they imply voluntary pursuit of goals by free choices, often mediated by documentation technologies. These properties introduce the *ought* dimension, and make humans cumulating information and using it to make decisions concerning more than just survival.

At the first level, that is typical of only-mechanical systems, the informational aspects consist of simple cause-effect relations involving matter and energy. Any information contained in the system, like the order in which the balls get arranged in the bag, is but a direct effect of external causes. Since the second level, however, the system itself (that can now be defined as a living organism) contributes to determine such effects, that is, to produce information (Fleissner and Hofkirchner, 1996: 248). Finally, at the third level, the system (now become a social net) is capable of modifying both itself and its external environment by completely autonomous decisions as well, thus creating fully original information.

The difference between the three levels can then be viewed as a progressive emancipation from the strict determinism of the physical world, through the intermediate stage of the limited freedom of living organisms, until human free will. Such process can be especially observed in the effects each type of entities has on its external enviroment: at the physical level, this can only be modified as a consequence of actions originated in the environment itself; at the biological level, it undergoes some feedback mediated by the greater complexity of living organisms; while only at the human level is it subject to really spontaneous and intentional manipulations.

Each stage is based on the previous one, as it could not exist without it, but it cannot be reduced to it. If the balls all had the same shape, size, weight, temperature, colour, smell, and position, they could not bear any information. Only in case an organism perceived the information that some of them are red, soft and fragrant, remembering of fruits, could it try to eat those ones. But only human beings could devise a game, or a secret military code, based on their colour and disposition on a board.

It is worth noticing that Stonier (1990; 1992; 1997), Bates (2005; 2006) and Bawden (2007) all came to similar results independently from Hofkirchner's UTI. Indeed, they also identify three levels of information organization – material, living, and social – connected to each other by an evolutionary process of emergence, from the more simple to the more complex. In particular, Bates overtly deals with a theme that is left in the background by UTI and the other cited sources: the immediate, synchronic (not just historical, diachronic) relationship that can be established at a given moment between information belonging to the three levels. According to her, "all information is *natural information* [that] exists in the material world of matter and energy". Only sometimes is part of it encoded or embodied in a living organism, thus becoming *represented information* that "is involved in representation at some moment of observation" and, in turn, can be partially used, especially by humans, as *exosomatic information*, "stored in durable form external to the body" and transmitted across generations (Bates, 2006: 1035-1037). In this way physical, biological, and cultural information would not only emerge one from the other in time, but would also be included one in the other at a given temporal instant.

Hjørland (2007) remarks that it makes no sense to regard as true information, as Bates does, even what lies only at the physical level and hence cannot inform anybody about anything before any organism capable of being informed has come to existence. Although this is a reasonable criticism, UTI and the other unitary approaches to the various meanings of *information* can overcome it, by just calling "potential information", "configurations" or "data" the purely syntactical information corresponding to UTI level 1 – as indeed Bates (2005) does when she writes that "animals perceive data, not information" –, and "actual information" or "meaningful data" the semantic information at level 2, and by putting them in a dialectical relationship (Ridi, 2010: 3-6).

After all, to use Hjørland's (2007: 1449) terms, the objectivist approach to the notion of information, according to which "any difference is information", and the subjectivist one, for which "information is a difference that makes a difference (for somebody or for something or from a point of view)", appear to be but two consecutive stages in the same evolutionary process, just as foreseen by UTI, rather than being each a negation of the other. In a world where living organisms have not yet evolved, or in a place where they are absent, the colour and arrangement of some balls clearly does not inform anybody about anything. However, as an organism perceives that, say, only one of the balls is red, this will make to it some difference, albeit minimal. These observations suggest that the properties of the balls just before being observed and just after that should be considered as related in some way.

This, among other things, would allow one to deal with otherwise scattered phenomena by the same conceptual schemes and within a single discipline. It would authorize to consider the content of books on shelves as information, or even as knowledge (though "potential"), even before they have been opened and read.

Finally, such an approach would be consistent with the hypertextual docuverse theory illustrated in the next section. According to it, everything potentially is a document, but it really becomes so, i.e. begins to be treated as a document, only when somebody actually considers it as such.

## 3. The hypertextual docuverse theory

Theories of the document (Lund, 2009), like theories of information, also face the challenge of the trilemma advanced by Capurro (2009). Indeed, they also have to decide if the properties of documents created and used by humans in their communication activities, like books or movies, can be extended to any kind of document, including e.g. dinosaur fossils; or if we should take in account so basic, universal properties that they are found even in "documents" not produced by humans for communication; or if the term *document* has to be viewed as taking a plurality of different meanings, according to its context.

The solution proposed by Ridi (2007) combines some distinct views concerning the subjective nature of documents (Briet, 1951; Buckland, 1997), hypertextuality (Nelson, 1990; Bolter, 2001), and the potential pervasivity and homogeneity of the documental universe or "docuverse" (Nelson, 1990): the complex of these views leads to what can be christened here the hypertextual docuverse theory (HDT).

Such theory is based on two premises:

(*a*) everything is (potentially) a document;

(*b*) every document is (potentially) hypertextual.

The first statement is based in turn on a classical (but still contoversial) definition of document, referred to by Buckland (1997: 805) as "any source of information, in material form, capable of being used for reference or study or as an authority". This statement represents a sort of principle of documental indetermination, according to which each observer creates, in a sense, her/his own documents: in this perspective, any object can be considered as a document, as it can inform at least in some minimal facet or in some circumstances. However, it is only when there is a specific (personal or, even more, social: Ridi, 2012) will of using, consulting, studying, keeping, and cataloguing a given entity as an information source that it really becomes so, as it is observed and used as a real document (Ridi, 2007: 16-17).

This view remembers of the approach of semiotics (Eco, 1976), according to which anything can be used as a *sign*, i.e. something that means something other for somebody: even a natural phenomenon, like the presence of clouds surrounding a mountain, can be interpreted as a sign of weather going to change by people possessing some local traditional knowledge. However, this notion makes no distinction between "documents" as pre-existing phenomena used to extract information by intelligent interpreters, like a cloud, a dinosaur fossil or the proof of a murder, and "documents" intentionally produced since their origin in order to inform about something, like a headstone, a book or a traffic signal (Gnoli, 2012).

Statement *b* above is based on a multi-part definition of hypertextuality (Ridi, 2007: 31-41), several elements of which agree with the structural properties of UTI information levels. A hypertext is a non-unilinear (and therefore multilinear) text, that is to say a document that does not necessarily need to be read following a unique order, established in advance by the author; on the contrary, it can be read at the reader's will. In this way the reader becomes, to some extent, a co-author, since she/he creates a personal path by moving from one point of the document to another. Therefore, any hypertext can be seen as a net composed of information nodes, connected to each other by links that users can freely run across.

Hypertextuality can be seen not just as a discrete property, either possessed or not, but also as referring to a *continuum* moving from a minimum degree to a maximum degree without leaps. One can found documents provided with greater hypertextuality, like encyclopaedia entries, web pages or linked data stores, as well as documents with less of it, like a novel or a poem. A unilinear document is then only a particular case of a very simple multilinear document, just like number 1 is only a case of a very simple number. All texts are hypertexts, more or less complex.

The fundamental precondition of hypertextuality is granularity, that is, the property of documents that can be decomposed into smaller self-contained parts still making sense and usable, as, for example, the single entries of an encyclopaedia. Indeed, only if a document can be decomposed into many nodes, will it be possible to connect them in many different ways.

Two other relevant components of hypertextuality are integrability and interactivity. Integrability means indefinite extensibility, that is to say the property for which, following the links in a hypertext by moving from a node to another, one can reach any point, without ever arriving to any particular end (or beginning). Interactivity (or malleability) is the possibility, for the reader, to creatively modify a document in ways unforeseen by the author, by either adding contents (i.e. nodes) or drawing new paths (i.e. links).

A last component of hypertextuality is multimediality. This can be a property either of individual nodes – which can be texts in a strict sense, still or moving images, sounds, or a mixture of them – or of the structure of links between them, that can be based on schemes, diagrams, images or other non-textual organizations. These can make the whole structure of an hypertext map-oriented rather than index-oriented, by favouring spatial organization over temporal organization. While the latter is more typical of linear texts based on an ordered sequence, like in lists, when facing an image or a map the readers can freely choose to pay attention to any of its parts, all simultaneously available to their look. For the latter case, then, some prefer to adopt the term *hypermediality* (Antinucci, 1993).

It is important to emphasize that not only texts in a strict sense (documents consisting of letters and digits) can be hypertexts, but also any other document type, as long as it has the described properties to some extent. As digital documents possess them more often than traditional ones, they are usually considered as hypertextual. However, strictly speaking, traditional documents can be hypertextual as well.

From premises *a* and *b*, the third and fourth theses of the theory can be logically derived. These theses concern the entirety of existing documents, that can be called *docuverse* (Nelson, 1990; Ridi, 2010: 134-138):

(*c*) universe and docuverse (potentially) coincide;

(*d*) both universe and docuverse can (potentially) be read as hypertexts.

If any physical object in the universe can – in certain circumstances, from certain viewpoints and for certain purposes – be used as an information tool, then the whole universe can be viewed as a huge collection of documents. Such collection is internally organized and interconnected in many different ways: from the simple structure of an animal imprint in the mud, until the complex relationships linking the various components of a university.

Hypertexuality lends itself better than other properties of documents to be coupled with such "pan-documental" interpretation of reality, as it can be scaled from degree zero to wide richness and complexity. Furthermore, being intrinsically permeated of the dialectics between objectivity of possible paths and subjectivity of actually chosen paths, hypertextuality is especially suitable to reproduce the analogous dialectics in the notions of information and of document: just like data are only potential information until they happen to be actually useful to someone, and an object is only potentially a document until it is treated as such in a social context – that is, until it is "read" –, it is only when a document is gone through by its readers along a plurality of itineraries that it really gives its latent hypertextuality off. Indeed, hypertextuality could also be considered as a property of document/user interactions, rather than a property of documents themselves (Landow, 1997).

The idea of "readability of the world", based on the comparison of nature with a book, has a long tradition. Blumemberg (1981) illustrates its main stages, starting from the Bible, passing through Galileo and coming to DNA. Knowledge of this ancient, influential history may help to see the equalization of universe and docuverse as not so weird. Indeed, it can be reconnected to the same cultural milieu that produced the idea of readability of the world, though deprived of the function of a deity that would warrant the correspondence, as being author of both the book and the nature. A similar correspondence can be observed between levels of reality and bibliographic classifications: we will discuss it in Section 4.

In light of our definition of hypertextuality, and its consequent pervasivity, the strong connection between docuverse theory and UTI should look obvious: indeed, in the latter's nodes, links and nets are central concepts, and the gradual transition to increasingly complex structures takes the form of increasingly rich and articulate links, establishing between simpler units as a consequence of evolutionary pressure. This produces the gradual emergence of systemic properties, just like a word has different properties than the sum of its letters, and a text has different properties than the sum of its words.

Comparison with docuverse theory, then, makes UTI's instrinsically hypertextual nature apparent. It also suggests in advance that both theories are compatible with the "it with bit" hypothesis, that will be described in Section 6: although the matter (*it*) of all objects in the world is always the same, the different ways in which it is organized into hypertextual information structures (*bit*) can explain the different properties emerging in increasingly complex objects, and the differences between individual objects, as well as between individual documents.

## 4. The theory of levels of reality

The idea that new forms can appear by evolution of pre-existing ones has now been applied in a wide variety of specific sciences, including astronomy, soil science, biology, linguistics, and history of religions.

When applied to the totality of known objects, as opposed to subdomains of them, it leads to ontological views tending to see all phenomena as connected in one and the same "chain of being" (Lovejoy, 1936). Phenomena can then be listed in a series of levels of increasing organization. In most cases this also means increasing complexity, although exceptions exist, like in the case of the evolution of parasite forms, which are usually simpler than their ancestors; more accurately, we can say that each level has a greater "logical depth" than the pre-existing ones, as more evolutionary steps had to be covered before it could came into existence (Bennett, 1987).

Such views can be traced in many authors back in the history of philosophy (see Juarrero and Rubino, 2008), though having become especially popular after the works of Charles Darwin, Auguste Comte and Herbert Spencer. These thinkers inspired the early-20th century school of evolutionary emergentism, championed by Samuel Alexander and Conwy Lloyd Morgan among others (Blitz, 1992). Explicit theorizations of reality as articulated into "integrative levels" (ILT), each based on previous ones but at the same time showing its own autonomy and novel properties, were then formulated by biochemist Joseph Needham (1943), by psychologist James K. Feibleman (1954) and – within the different tradition of Germany philosophy – by ontologist Nicolai Hartmann (1940).

Theories of levels, in turn, have been adopted by developers of several bibliographic classification systems. In the context of library and information science, classification is a way to sort disciplines (or directly their objects of study) in some useful order to be browsed and searched. Some bibliographic classifications, like Dewey, adopt a conventional order (originally based on Francis Bacon's identification of memory, imagination and reason as the main forms of human knowledge). However, other authors have tried to ground the order of their main classes on the nature of the studied objects themselves, that is, on ontology. To this purpose level theories can help, just because they offer a rationale to identify "lower" and "higher" classes of entities, thus producing a general sequence of classes.

The principle underlying this approach is indeed a historical, evolutionary one (Gnoli, 2006; Hjørland and Gnoli, 2009): each class of things is seen as having emerged from pre-existing ones at a given stage of cosmic evolution. In bibliographic terms, the notion of levels usually corresponds to that of "gradation in speciality" (Mills and Broughton, 1977): phenomena at lower levels of organization, like material bodies, are those studied by the least specialized disciplines, like physics, whose laws hold for a wider range of phenomena: not just molecules and rocks have a mass and a temperature, but also cells, human bodies, or artifacts. At the other extreme of the sequence are phenomena of highest levels, studied by the most specialized disciplines, like the humanities, which only account for the special properties of their particular objects: discussion in terms of styles and schools applies to literary works, but it does not make sense for rocks or cells.

Although the various implementations differ in details, and several questions remain open to discussion, a common general pattern can be identified in all these classification systems, as they start with very general subjects, like philosophy or mathematics, and go on through physics, geology, biology, ecology, psychology, sociology, economics, up to arts and the humanities (Richardson, 1901; Bliss, 1929; Dahlberg, 1978; Foskett, 1978).

The exact number of levels in these systems appears to be influenced by both tradition (what is studied by a consolidated discipline is worth to be considered as a separate class) and notational bases of the systems (systems using letters, like Bliss Bibliographic Classification, have about 25 main classes, while systems using digits, like Information Coding Classification, have 10).

This would suggest that the identification of levels is purely conventional. However the opposite, ontological approach is also possible: levels can be identified as classes of phenomena observed in the real world that share the same sets of categories, that is, the same properties (Poli, 2010). Properties are modeled in bibliographic classifications as facets of main classes: for example, living organisms typically have organs and functions, which are represented as facets of the biology class; arts typically have styles and genres, which are represented as facets of the arts class. Thus the level of living organisms can be defined as the set of all phenomena that can be effectively described and indexed in terms of organs and functions, or the level of art works as the set of phenomena that can be described in terms of styles and genres.

In this respect, UTI is especially interesting just because it offers its three types of information as an explicit, not idiosyncratic criterion to identify three major levels of organization:

(1) the realm of entities in which information is just a configuration of elements, depending passively on external influences, forms the material level. Balls in the bag, or molecules in a rock, only change their properties based on external input, either direct or indirect. Their information content can change in this way, either voluntarily, e.g. a human carving the rock or coding a message by moving the coloured balls, or involuntarily, e.g. wind eroding the rock thus changing its shape or an earthquake dropping the bag thus altering the arrangement of balls in it;

(2) the realm of entities that, additionally, contribute to change information within themselves, in their offspring and in their environment. Macroscopical examples of this are bee dances, beaver dams, self-mutilations (an extreme but meaningful case), and any action improving or decreasing reproductive success; while microscopical examples are photosynthesis, digestion, aging, DNA transmission and decoding. Mechanisms regulating the genetic information stored in DNA and controlling metabolism and homeostasis are critical to the identification and description of this realm, that forms the organic level;

(3) the realm of living organisms that, besides producing temporary changes in their environment for practical purposes (like building dams or nests), also store information in objects they made specifically for communication purposes, that can reach later generations even very far in time. At such socio-cultural level, information is stored not only in the body (DNA, nervous system, etc.) but also in external artifacts that are kept and socially exchanged on purpose. Indeed, some authors (Ferraris, 2009; Searle, 2010) identify the ontological basis of human societies just in this type of communication objects.

Therefore in UTI, just as in Bawden's tripartition, “the linking thread, and the unifying concept of information [...] is organised complexity. The crucial events which allow the emergence of new properties are: (1) the origin of the universe, which spawned organised complexity itself; (2) the origin of life, which allowed meaning-in-context to emerge; and (3) the origin of consciousness, which allows self-reflection, and the emergence of understanding, at least partly occasioned when the self reflects on the recorded knowledge created by other selves” (Bawden, 2007: 318-319).

A similar view has been adumbrated by biologist François Jacob (1970) when observing that the major evolutionary transitions, like matter to life and life to mind, all coincide with the appearance of some memory mechanism: indeed, life is possible as the genetic memory is established, and mind is possible as the neural memory is established. Memory is nothing but storage, organization and retrieval of information. Thus, again, information can play a key role in the identification of major integrative levels.

Taking Jacob's idea as a source of inspiration, and comparing it with the various theories of levels that have been advanced by many authors, one could extend the list of major levels until five, if the socio-cultural level is further analyzed into the appearance of human consciousness, of spoken language, and finally of writing and recordable media (Table 1).

| ***level*** | ***memory*** | ***units*** | ***variability*** | ***pressure*** | ***selection*** |
|---|---|---|---|---|---|
| matter | negentropy | structures | bifurcation | probability | stability |
| life | genome | characters | mutation | environment | fitness |
| mind | remembrance | notions | learning | experience | relevance |
| society | language | customs | innovation | competition | success |
| heritage | media | written documents | theories | critics | acceptance |

*Table 1: Five major levels (strata) of phenomena and corresponding factors of evolution.*

As each new kind of memory appears, new evolutionary processes of variability generation, environmental pressure and natural selection start. For example, at the level of society, the appearance of language as an oral memory allowing to represent features of the environment and to share information about them triggers the development of a variety of social, political and economical customs. Innovations are a source of variability that can be shared and spread through the oral memory. However, they have to compete with alternative customs, under the selective pressure of the natural and social environment, so that only some of them will have a good success and a wide diffusion across space and time.

While these levels cover the major evolutionary transitions, it can be noticed that ILT and classifications based on it also include other, minor transitions, like those from atoms to molecules or from tribes to national states. It is not clear whether information can play any role also in these latter cases. In Hartmann's version of the theory, the major levels, like material or organic, are called “strata” and connected by an ontological relationship of “building above” (life is built above matter, etc.), while the minor ones, like atomic or molecular, are called “layers” and connected by a different relationship of “overforming” (Hartmann, 1940). Of these relationships, only the “building above” ones seem to be associated with new forms of information and memory.

## 5. Some pros and cons of the three theories

None of the theories discussed above – UTI, HDT, and ILT – is scientifically proved, nor perhaps provable. Also, none is currently predominating in its academic and professional domain.

Furthermore, each of them can show some weaknesses. For example, UTI seems to put an exceeding emphasis on freedom, which would intervene already at the biological level, then more strongly at the cultural level, every time genuinely new information is produced, despite the fact that determinism is currently the prevailing conceptual horizon in both science and philosophy (Gazzaniga, 2011). HDT, for its part, may put an exceeding emphasis on hypertextuality itself, as after all hypertextuality is but one among many properties of documents, not to mention the fact that it prevails mainly in digital media, that are only a very recent type of them.

Another relevant criticism can be moved against both UTI and ILT: that is, that they take as sharp and discrete a wide variety of boundaries often manifesting themselves, on the contrary, as hazy and continuous. Discussion about the point, way and time of transition from inanimate matter to life is a long, historical one: even today, viruses are sometimes considered as an intermediate form between molecular compounds and living organisms; while physical phenomena like radioactivity, or theories like quantum physics, can suggest some degree of autonomy even in inanimate matter. Not to mention the discussion that has continued for more than two thousand years – from Democritus to Damasio (2010) – about the degree of continuity between the body and the mind.

Also, although the human levels are said to feature special properties, like complex social systems passed on in non-genetic ways and collective purposes transcending bare survival, according to scientific research it is not out of question whether non-human animals can have developed some forms of cultural production and transmission (Cavalli Sforza, 2004) or even of morality (Waal, 2006); or whether insects like bees and ants form societies of complexity comparable with that of human ones (Wilson, 2012); or whether human civilization has really developed radically different purposes from the very natural one of group survival (Miller, 2000).

Even the number of strata into which reality would be subdivided varies according to the different versions of levels theory, raising doubts about their objectivity; it equals 3 in UTI, where the recurrence of this number across many parts of the theory could be suspected of being inspired by some “cabalistic” aesthetics.

Despite all this, each of these theories has in our opinion internal consistency and explicative power enough to be a rationale – if not necessarily for describing the real structure of the universe (which nevertheless not all their authors claim explicitly) – at least for working as an effective conceptual scheme: indeed, they allow to classify, unify and understand a wide range of phenomena otherwise unordered, scattered and difficult to grasp, as well as to provide an interesting, non-canonical view of them. This heuristic function cannot but be substantiated and reinforced by the numerous elements of agreement between the three theories, that we hope to have made clear in our discussion.

Such a heuristic, “hermeneutic” approach, promoting a set of useful interpretations of reality without claiming to be catching its genuine essence once and for all, would also play down the question of the number of levels into which reality should be objectively structured. Indeed, if the purpose is simply to create a general conceptual grid onto which particular ontologies and classifications can rest, in order to enhance their consistency, economicity and interoperability, then the number of levels that are identified could change according to the purpose and context of application. The best option could be to opt for a number of levels high enough to receive most proposals in levels theory literature, and to provide a hospitable ground for a possible mapping between different classification schemes, and their coexistence.

If, on the other hand, the purpose is to provide philosophy of information with a conceptual foundation to consistently integrate the various meanings of *information*, then Ockham's razor principle would suggest to limit oneself to the minimum number of strata allowing for this: UTI, Stonier, Bates and Bawden all have done it with three strata.

## 6. “It from bit”, “bit from it”, “it with bit”

Those who, instead, consider the hermeneutic-heuristic approach to be excessively bended towards postmodern relativism, even in light of the recent discussion on “new realism” (Ferraris, 2012; Vattimo, 2012; Santarcangelo and Scarpa, 2013), may prefer to venture a metaphysical explanation on how the world is “really” done.

They can then turn to philosophical ontology, the field devoted to the identification of fundamental kinds of existing things. In this sense, for example, is directed Roberto Poli's speculation, according to which an ontology of domains, meant as partitions of knowledge reflecting partitions of the real world, first has indeed to face the question of how to “rip the world to pieces”. As mentioned above, identification of the different domains (material, mental, social, and their versions and subdivisions) can be based on the observation that in each of them a different set of categories holds (Poli, 2011): of these, some are common across all levels, like time is in most models, while others are only peculiar of some levels, like homeostasis being a property of organisms but not of inanimate matter. Categories appearing only at a given level can then be seen as its emerging properties postulated by ILT. The demarcation between two levels, hence between two disciplines in knowledge organization, would be not arbitrary, but rooted in the different domains where the major properties can be found.

Along this way, the ontologist could even be tempted by a further reduction in the number of strata. These, at this point, could be rather called “substances”, “attributes” or “elements”, without necessarily arranging them in any progressive order nor considering their emergence from previous ones. In this perspective, “the world, it seems, runs in parallel, at many levels of description. You may find that perplexing; you certainly aren't obliged to like it. But I do think we had all better learn to live with it” (Fodor, 1997: 162). This is just what would happen with a Spinozian universe formed with infinite, parallel attributes, of which only two – thought and matter – accessible to humans (Donagan, 1988: 122-125). The most radical reduction could draw from the vast catalogue of metaphysical monisms offered by classical philosophy (from Thales's “everything is water” until Schopenhauer's “everything is will”).

Otherwise, our ontologist, especially if professionally involved in library and information science, could be intrigued by the more recent “everything is information”, expressed with some variations by Wiener (1961), Landauer (1967), Wheeler (1990), Davies (2010) and Floridi (2011). It was American physicist John Archibald Wheeler who coined for this view the incisive slogan “it from bit”:

> “It from bit. Otherwise put, every 'it'—every particle, every field of force, even the space-time continuum itself—derives its function, its meaning, its very existence entirely—even if in some contexts indirectly—from the apparatus-elicited answers to yes-or-no questions, binary choices, bits. 'It from bit' symbolizes the idea that every item of the physical world has at bottom—a very deep bottom, in most instances—an immaterial source and explanation; that which we call reality arises in the last analysis from the posing of yes–no questions and the registering of equipment-evoked responses; in short, that all things physical are information-theoretic in origin” (Wheeler, 1990: 5).

This approach is in some way opposite to the more traditional “bit from it” (Barbour, 2011), assigning to things a strong priority as compared to any kind of information.

A compromise between these alternatives could be a form of metaphysical dualism, that can be summarized in the saying “it *with* bit”. This would simplify Stonier's (1990) proposal of identifying matter, energy and information as the ultimate elements of the universe, in the light of the substantial equivalence between mass and energy claimed by contemporary physics (see Einstein's famous equation $E=mc^2$).

We would thus remain with two fundamental elements at the basis on any reality: on one side, Wheeler's “it”, that is everything that Aristotle would have considered simply as “matter”, but nowadays we find scattered in physics handbooks under tens of names (from mass to energy, through electromagnetic waves, gravitational force, and that strange thing improperly called antimatter); on the other side, Wheeler's “bit”, that is what Aristotle called “form” and we could call organization, structure, order, or information. Universe, then, would be made of something (it) ordered in some way (bit), or in Aristotelian terms would be an indissoluble union of matter (potentiality) and form (actuality).

> "In Aristotle's system, whenever some thing is differentiated from other things – whenever it is *this* rather than *that* – it is distinguished thanks to its form. Pure matter, then, must be purely undifferentiated stuff. Matter is the *hypokeimenon*, that which lies beneath (cfr. the Latin *subjectum*); it is what takes on all the properties of the things without itself having any intrinsic properties. But if it has no form and properties of its own, it cannot be directly grasped by reason. [...] Matter is that unknown which, when combined with form, produces this or that specific object. But taken by itself it is completly unknown, mysterious" (Clayton, 2010: 42-43).

Elements in "it/bit" and "matter/form" pairs, then, would not be in the same relationship as two levels in levels theory. They would rather be orthogonal to levels of reality: each stratum would be identified exactly by a different organization of matter. Matter would always be the same, but would take a different form at the physical, the biological, the socio-cultural levels, depending on its increasingly complex structure. This is also suggested by the very etymology of the word *information*, coming from Latin *informatio* meaning especially the procedure of "giving form", in both tangible and intangible senses (Capurro and Hjørland, 2003: 350-353).

To further connect the three theories we are discussing, if one accepts the radicalization of UTI and ILT in the "it with bit" hypothesis, a good example of the nature of both the whole universe and each part of it would be just a document: that is, a piece of matter (*it*) that contains information as it is ordered in a certain way (*bit*). This would give an objective sense, rather than only a subjective one, to the thesis that "everything is a document" proposed by HDT. On the other hand, Aristotle himself used the example of a statue (Clayton, 2010: 41-42), that is of a type of document, to explain the relationship between matter and form.

We should remind anyway that the "it with bit" hypothesis is compatible with both UTI and any other theory of levels (either ontological or heuristic) providing for any number of strata, and allowing for the correspondence of a particular way of information organization to each of them. In this perspective, philosophy would limit itself to hypothesize a minimum number of fundamental components of reality (matter-energy and information). It would leave to scientific disciplines, including the one looking for the best ways to organize knowledge, the evaluation of which are, at the current stage of human knowledge, the forms of matter organization – that is the information structures than can give form to matter – different, relevant and useful enough to identify a distinct level of reality.

## 7. Conclusions

Coming back from speculations to our main thesis, we have seen how Hofkirchner's theory is compatible and agrees in several points with the theories of hypertextuality and of levels of reality. Each of these approaches can contribute fruitful arguments to the other ones. In particular, we hope to have shown in a convincing way how UTI is a special kind of levels theory based on hypertextuality.

A common way of thinking connects all these theories. It is based on the acknowledgment that reality can be analyzed as an evolutionary process, starting from simple elements that form networks of increasing complexity, and give origin to novel properties.

According to Hjørland's (2005) classification into four basic approaches to information science (empiricist, rationalist, historicist, and pragmatist), the evolutionary approach could be reconnected to the historicist one: indeed, both evolution and history are long-term processes that are studied in their development across time. However, we should emphasize that what we propose to study under an evolutionary perspective is not the whole domain of information science as described from outside (e.g. by reconstructing influences that have historically led to a certain school of information scientists), but the objects themselves studied by information science. These include documents, their subjects – that can be indexed by systems based on evolutionary principles – and, like in this paper, the very notion of information.

**Note**: Although the whole paper was developed by the authors in full collaboration, responsibility is mainly by Ridi for sections 1, 3 and 6, by Gnoli for sections 4 and 7, and by both for sections 2 and 5.

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