On Praxiological Information

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Abstract

In this paper is outlined an action-oriented philosophy of information, namely praxiological information. The praxiological kind of knowledge and some of its species (behavior, communication, computation, information, attention, learning,) are introduced by the method of generalization and classification. By exploiting the metaphor of the spectrum of colors, the architectures of behavior, communication and computation are shown as if they were primary colors: red, yellow and blue. The architecture of information (green) is introduced by joining together the architecture of computation (blue) and communication (yellow). The principle of information, that is the Data Operational Principle, is stated; the informational bearers, that is messages, are explained; the informational criteria, that is connectivity and compatibility, are outlined; The architecture of attention (orange) is introduced by joining together the architecture of behavior (red) and that of communication (yellow). The criterion of attention, that is relevance, is pointed out.

Index terms— generalization, praxiological-information, system, connectivity, compatibility, relevant information, effective information, synthesis.

I. The Praxiological Kind & Species of Information he seeds of the philosophical meditation on the notion of information-action oriented were planted very early by Rosenblueth, Wiener and Bigelow in "Behavior, Purpose and Teleology" **??**1943).

In this article I will present the trees of knowledge which are grown from those seeds. They are trees of different species and I name the kind of which the several trees are species the praxiological kind. The fruits of those trees are informational phenomena and, being them of the species of which the particular tree is, they represent the several species of the praxiological kind of information. Praxiological information, as I conceive it, has to be understood as a term which consists of the union of the term "praxis" that in philosophy designs the practical activity as different from the theoretical activity, and the term logical, that in this case refers to the theory which takes into account the implementation of informational phenomena, dynamics and technologies.

At the philosophical lecture the paper of Rosenblueth, Wiener and Bigelow is relevant because it introduces a method of generalization and classification of the external structural properties or invariants of the objects by which the study of the objects is carried out irrespective of the analysis of their internal functional structures (which usually are regarded as black-boxes). The method of generalization is a method quite intuitive and particularly used in mathematics (Mac Lane, 1986) and in science in general, being it the usual method of laboratory of the scientist which consists in isolating the object in an experimental stance and which consists in the classification of the object in terms of its external observable properties, that is in terms of its input-output relations. This input-output relation is the cause of the change and therefore it is regarded as the behavior of the object which, observed in its input-output relations, becomes a system or, philosophically speaking, a phenomenon. Here the philosophical sharping difference between what is hidden, that is the internal and not observable structure of the object, and what is not hidden, that is the external, observable and classifiable behavior of the object, applies. Now, if the black box is the metaphor from the point of view of the internal functional analysis of the structure of the system, I will propose, from the point of view of the analysis of the external structural properties or invariants of the system, the metaphor of spectrum of colors. In according to the theory of colors, the spectrum of colors is composed of the primary colors: red, yellow and blue; by the secondary colors: green, orange and violet, which are obtained by the union of the primary; and by all the other infinite gradations of colors which are obtained by joining together the primary and secondary colors.

I will name architecture or colored box the external structural properties or invariants of the system to distinguish them from the internal functional structure of the system that, in according to the common use and scientific practice, is called black box.

In the distinction between black box or internal structure and colored box or architecture the point is to stress what are the primary constituents of the ontology of the theory. In the case the study is carried out on the internal structure the primary constituents of the ontology are objects and set of objects, whereas in the case in which the study is carried out on the external properties or invariants of the structure (that is on its architecture) the primary constituents of the ontology are structures and set of structures. The same thing can be said by naming the internal structure as semantic structure and the external structure as ontological structure and remarking that both kinds of structure are functional.

Naturally, as an Italian, I prefer to put the difference in term of aesthetics, but I have to alert that, because of the subtle threat among beauty, good and right and of course among its contraries, the metaphor of black box and colored box is much more than an aesthetic metaphor. Evidently, given that my framework is that philosophical between power and action, here we are facing that dilemma of the white side of the force and the dark side of it.

According to the above metaphor the architecture of the system is represented by the red box (fig. 1). Now before to proceed it is to note that, by the method of generalization and classification, the teleological cause is introduced in the classification of the behavior and therefore in the scientific explanation of the system. It is to remark that the teleological cause distinguishes completely this behavioral approach from the psychological behaviorism in which framework the cause is regarded always as an efficient cause.

According to the relation input-output, the behavior is classified in active/non active (or passive) behavior. The active behavior is classified in purposeful/purposeless (or random) and for purposeful behavior is meant that the action is directed to a goal. In turn the purposeful behavior is classified in teleological or feed-beck and non-teleological or non-feed-beck behavior where for feed-beck or teleological is meant that the output reenter in the incoming input. The servomechanich concept of feedback is the generalization of the physiological, biological and ecological concept of homeostasis **??**Cannon, 1932). The concept of teleology was challenged in biology by that of teleonomy **??**Pittendrigh, 1958) to point out that the goal-directedness is not committed to the Aristotelian teleology as a final causal principle and subsequently the term teleonomy has replaced the term teleology in Cybernetics (Monod and Francois, 1961) and it has entered in the scientific practice, from the natural to the social sciences, being it closely related to the concepts of emergence and self-organizing systems.

Moreover the feedback behavior is classified in positive and negative feedback. For negative feed-beck is meant "control by the margin of error at which the object stands at a given time with reference to a relatively specific goal" (Rosenblueth, Wiener, Bigelow, 1943, p. 2). Finally the feed-back purposeful behavior can be classified in extrapolative or predictive and in non-extrapolative or non-predictive; and the predictive behavior can be focused at several degrees of complexity (fig. 2). "Active behavior is that in which the object is the source of the output energy involved in a given specific reaction. The object may store energy supplied by a remote or relatively immediate input, but the input does not energize the output directly. In passive behavior, on the contrary, the object is not a source of energy; all the energy in the output can be traced to the immediate input (e.g., the throwing of an object), or else the object may control energy which remains external to it throughout the reaction (e.g., the soaring flight of a bird)" (Rosenblueth, Wiener and Bigelow 1943, p.1).

Moreover at some level the active behavior manifests as teleonomical where for teleonomical is meant negative feedback which consists in a sort of circular causality by which the output is returned in the incoming input of the system and it corrects its outcome. It is exactly this process of negative feedback that is responsible of the organization, that is information, of the system.

In what follow I will show that the architecture of behavior outlined above is isomorphic to many informational phenomena. In fact the method of generalization and classification of the external properties of the object (that is of its behavior) is at the core of the discovery that the input-output relation is a general servomechanic architecture that is structurally identical to many informational phenomena. I will outline the structural identity among behavior, communication, computation, information, attention and learning. At first, in the next paragraph, I will outline the structural identity between the behavioral system and the communicational system. My move is perfectly coherent with the idea of N. Weiner (1961) who founded Cybernetic as the science of control and communication and envisioned that the apparatus input/output of the agents (of which subclasses are the perception-action apparatus of animals and plants and the afferentefferent physiology of neurons) is isomorphic to the process of communication. And at least this is my way of seeing the things. In the following paragraphs I will outline all the other structural identities constructing them with the metaphor of the spectrum of colors.

1 II. The Praxiological Architecture of Communication

The basic idea of Shannon"s "The Mathematical Theory of Communication" (MTC), usually just called "information" theory, is to measure the quantity of information or entropy H of massage with the logarithm N of the number of equiprobable messages:

2 log(N)= bit for Msg

If the occurring messages are equiprobable, the quantity of information of each message is given from the probability of occurring of that message multiplied for the logarithm of such a probability:

3 H= p1 log/p1

The function that defines the quantity of information generated from the source is defined as the natural logarithm of the sum of messages:

4 H= (log (N)+log(N)2 +?) bit for msg

If the occurring messages are not equiprobable (as it is in natural language) the function that defines the quantity of information generated from the source is the sum of probability (p1,p2,p3,...) of the occurring messages multiplied for the logarithm of such probability: H= (p1 log/p1+p2 log/ p2 +?) bit per Msg;

The Shannon's approach to information is a quantitative approach and specifically the information contained in a message depends on the probabilistic distribution of the source, which is called entropy, in a way that the amount of information of a message depends on the inherent uncertainty of the source. Practically the quantity of information is a measure of uncertainty, that uncertainty that has been removed after observing the outcome of the source.

As Shannon (1948) pointed out "Frequently messages have meaning; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantics aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one selected from a set of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since is unknown at the time of design".

Later in its life, Shannon (who was not a philosopher), in according with the preceding view, identified three levels of problems in the study of information. The first is the technical level and it is the level which MTC is about. The second and the third are respectively the level of the problem of the content of information and the level of "effectiveness" or of the way in which the content of information affects the conduct of the receiver of that content. The second and third problem have attracted the attention of philosophical investigations being closely related to semantic and pragmatic studies.

Nevertheless the dogmatism with which the contemporary philosophers of information have assumed MTC and the task of solving the semantic and pragmatic problems of Shannon as the necessary foundation of their philosophies of information seems to me unsatisfactory nor it seems to me the only viable possibility for philosophy.

In fact there is a third view to consider MTC and his huge, even if partial, contribution in the account of the phenomenon and concept of information. This view is the praxiological view and it attempts to answer to the question of what information is nor in a quantitative way by offering a measure of its quantity (the Shannon's measure in this respect is completely satisfactory even if it is not the only viable measure of information, in fact another quantitatie measure of information, which is pretty different even if complementary to that of Shannon, is given by Kolmogorov complexity) nor in a semantic or pragmatic way by analyzing the meaning of information. The praxiological view holds for a qualitative analysis of the communicational systems and answers to the question of what information is by analyzing how information acts. There is a slogan for this view: information is what information does.

By the praxiological genus of information the Shannon and Weaver's model of communication is considered as one of the species which manifests an informational nature and it is investigated in the usual laboratory approach which consists in to live aside its internal structure 1 and which instead focuses the attention on the architecture of the communicational objects.

The communicational object is a system that conveys information from the source to the receiver and it is constituted from a couple of objects, input and output, everyone assuming a finite number of states, and by a channel by which communication flows. Any state of the input is coded by a symbol of the finite alphabet X and any state of the output is coded by a symbol of the finite alphabet Y, and if the input is in a certain state x belongs to X, than the output assumes any state of Y with a certain probability depending exclusively from x.

So that the external structure of the communicational model configures as architecture input-output and it is structural identical to the architecture of behavior. Accordingly we assign the yellow color to the architecture of the communicational model, which considered in its input-output relation, becomes a system (fig. 3) or, philosophically speaking, a phenomenon. Now, just this architecture holds for a praxiological approach to the study of communication. Our praxiological approach consists in observing the relation input-output of the system, that is in observing the behavior of the system, and consists in a classification of the communicational behavior.

Taking into account the architecture of the system the communication is classified in connected/non-connected. In the above classification the criterion of the communicational architecture is connectivity. In fact it is pacific that if in the process of communication the source and the destination are not connected then there is not communication at all or, at least, there is only useless communication.

It is to note that the classification of the communicational architecture does not have other criteria besides connectivity, differently from the classification of the architecture of behavior (see figure 2), because the Mathematical Theory of Communication is a syntactic theory and in such a sense it is behavioristically poor.

5 III. The Praxiological Architecture of Computation

By the praxiological genus of information computation represents one of the species which manifests an informational nature and it is considered in the usual laboratory approach which consists in to live aside its internal structure and instead consists in focusing on its architecture.

Today computation represents a broad field of investigation. But for this attempt it will suffice to take just a look of the Theory of Automata.

Automata Theory studies the relation among three objects: grammar, language and machine. The grammar can be thought as representing the generativity, the language the definability and the machine the acceptance or recognition. Now without entering in the details and without loss of generality the important thing to note here is that there are different classes of grammars that generate different classes of languages that can be recognized by different but appropriate machines. For example a regular grammar generates a regular language which expressions or words are accepted by a deterministic state automaton (DFA). In such a sense the grammar and the automaton must be compatible otherwise the automaton for that expression generated by the grammar cannot be constructed.

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The internal functional structure of information is the basic concept under analysis in Floridi"s and Dretske"s philosophies of information which hold for semantic notions of information. Both philosophies of information are representationalist and post linguistic philosophies of information and moreover both philosophies have their foundation on the Mathematical Theory of Communication disregarding completely the computational side of information and all its other myriad of aspects.

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The place and the between in which this compatibility holds or does not hold is the formal language.

These architecture that I have just now described is the most general generalization (if the expression can be bypassed!) of computation and it can be focused at a lower level of the simple physical automaton. In fact the architecture of the automaton can be thought as subclass of the architecture of computation.

Without loss of generality we can take as our model the Deterministic Finite Automaton (DFA) which is the most simple automaton. DFA has two levels of description, the hardware and the software level.

At the hardware level the automaton is a machine consisting of five components: a single internal register (finite control), a set of values for the register (the states), a tape, a tape reader and an instruction set. At the software level DFA is a quintuple M = (Q, ?, ?, q?, F), where Q is finite set of states, ? a finite set called the alphabet, q? Q a distinguished state known as the start state, F a subset of Q called the final or accepting states, and ? a total function from Q ? known as the transition function.

Now it is to note that in each physical realization of the automaton the hardware must be compatible with the software and vice versa, otherwise the computation is impossible. Everybody today knows this simple law of technology. The place and the between in which hardware and software match and show their compatibility is known as the interface. Now being the architecture of computation like that I have described one can think to computation as a couple of systems: input and output representing respectively grammar and automaton at the most general level of Automata Theory and hardware and software at the more specific level of the automaton.

So that, accordingly to the metaphor, I assign the blue color to the architecture of computation, which considered in its input-output relation, becomes a system (fig. 5) or, philosophically speaking, a phenomenon. Now, just the above computational architecture holds for a praxiological approach of the study of computation. Our praxiological approach consists in observing the relation input-output of the system, that is in observing the behavior of the system, and consists in the classification of the computational behavior.

Taking in consideration the architecture of the system the computation is classified in compatible/noncompatible (fig. **??**).

7 Fig. 6 : Classification of the architecture of computation

In the above classification compatibility is the peculiarity of the computational architecture in respect to the behaviorist and to the communicational architectures. In fact it is pacific that if in a computational engine the hardware and the software are not compatible then the machine does not work. Otherwise standing to the general architecture of the classes of regular grammar, regular expressions and Deterministic State Automata that I have outlined above it is demonstrable that if some non regular expression is introduced then can be shown that the DFA that accepts that expression cannot be constructed. The same is true for the all the other classes of more sophisticated automata which show their compatibility one to one with the Chomsky hierarchy of gramars.

It is to note that the classification of the computational architecture does not have other criteria besides compatibility, contrary to the architecture of behavior (see figure 2), because the Theory of Automata is a syntactic theory and in such a sense it is behavioristically poor.

8 IV. The Architecture of Information, Messages & Data Operational Principle

At this point I have analyzed, and of course the method of generalization is fully loaded already of synthesis, three different but isomorphic informational architectures and, accordingly to the metaphor, I have assigned a primary color to each one of those. Now my task is to make a synthesis, in the philosophical sense of synthesis as the moment following the analysis. Accordingly to the metaphor the synthesis will consist in the union of the primary colors to obtain the secondary colors and to complete the spectrum of colors.

At first we join together the architecture (yellow) of communication with that (blue) of computation. By joining the architecture of communication and that of computation we obtain the architecture of information which results to be of green color (fig. **??**) Fig. **??** : The Architecture of Information It is pacific that information inherits the criteria of communication and computation, that is connectivity and compatibility.

But now there is to outline the informational bearer. Messages are our candidates and this is in agreement with the scientific practice even if it is in disagreement with the contemporary philosophies of information which instead assume propositions, factual or intentional, as informational bearers.

Certainly messages have more than fifty years of well established scientific status. In fact they have a quantitative measure by the Mathematical Theory of Communication. But we do not want only a quantitative measure of the message. In fact we are searching for the architecture that all the messages share. This architecture is our guarantee of the functionality of messages to play the rule of atomic constituents of information.

The architecture of message is composed of three alphabets (fig. 8): Now by the architecture of the message we directly derive the principle of information that I name the Data Operational Principle (DOP) which completely distinguishes this approach from the semantic, pragmatic and logical pluralist approaches to information which instead take as principle the Data Representation Principle (DRP) **??**Floridi 2005 **??** Allo 2007).

The DOP, in its negative formulation, tells us that there is not information without data operation and, in its positive formulation, asserts that information is made by the data encoding and decoding operations (fig. 8).

But that's not all. In fact now there is to outline the infinite process of information. It is implicit in the2 20 2 36 ( ) H a) injective: x n(f(x) = f(n)) ? x=n; b) surjective: m AS n AD F(n)=m

Data Operational Principle because in the Alphabet Code there is the codification of the alphabet data in the alphabet symbols and vice versa. The infinite process of information is that process by which a code can became data for another code and so on and so forth ad infinitum. This is the infinite process of information (fig. **??**). Fig. **??** : The infinite process of information This figure drawn above has to be regarded as a section of the spherical spiral but to offer an exhaustive image of the infinite process of information is an enterprise that belongs to that field of human knowledge called Logic of Scientific Discovery and therefore it is not my goal in this paper. For the moment it is to remark that I have outlined the architecture of information, the informational bearers, the principle of information and the infinite process of it. But now there is to face with one of the deepest questions of our epoch: where is information?V.

Where is Information?

The story of "Where information is" is the biggest question of the science of our time and certainly one has to be scientifically and philosophically minded (where only one of the two is not enough) to appreciate the whole of this claim.

The story of where is information is a bit the story of relevant information. As Saracevic (1975) reveals, relevant information is an elusive human notion and Information Science comes to the light for treating, with logic and philosophy, the concept of relevance.

The story of Information Science is a bit the story of the virtual library of the future. It is an on-line library and the total knowledge is in the books of that library. It is a bit as the library of the magic, all the magic that exist is in the books of that library. As far as the production of knowledge increases and the library becomes more and more comprehensive, in the virtual library, as well in the library of the magic, the question of the location of information, that is "where is information?", become more and more relevant.

As it is emerged by information science literature, there are two way of theorizing the taking information as the content of the enunciation (the content of the factual sentences as "the lawn is green" or of the intentional sentences as "she believes that the lawn is green") would mean that information does not distinguish from content. At this point the semantic theories of information elect as criterion of information the truthfulness of it and this is enough to distinguish the content of the enunciation, which can be true or false, from the content of information which is only true. I think that the truthfulness of information, if not a dogma, is nothing at all. But in anyway, let it be what it is, analyzing information in terms of true content, factual or intentional, that is to say that in the most part of cases we are merely informed and we do not know really. So that the semantic conceptions of information need a theory of justification which asserts that not only the content of information is true but, to count as knowledge, it must be justified. Therefore they assume as theory of justification the relevance of information. Now, there are two way of interpreting the Data Representation Principle which depend on two way of interpreting the representation.

The doctrine by which representation directs toward the entity, for showing it in the enunciation in the manner in which it is, holds for the opinion that representation joins the things (res) in themselves and what the things belong (reality) and it is called realism.

The doctrine of representation which doubts that the representation joins the entities in themselves instead of staying in the environment of its proper activity (soul, spirit, conscience, ego) holds for the opinion that the representation refers only to itself as representation of a representation and it is called idealism. Standing to this antique philosophical dispute, the semantic theories of information divide in two doctrines.

phenomenon of relevant information: agentive (subjective) oriented relevant information and system based (objective) relevant information.

The contemporary Semantic Philosophies of Information share this same bipartite and out-out analysis with Information Science. In fact objective and subjective are semantic and representationalist features. The semantic theories of information, in according with Nauta (1972), are representationlist and post linguistic theory of information. In fact they assume as principle of information the data representation principle (DRP) which states: ”no information without data representation” **??**Floridi 2005 and Allo 2007). Representation, from the antiquity up to now, involves a theory of truth. Truth, in fact, from the antiquity up to now, means correctness of the enunciation and an enunciation is correct if it is directed towards the entity and what it claims represents the entity. It enunciates about the entity ”what it is like”. The enunciation is the place of truth, but not only, it is the place of falsity, of the lie. Now, for the semantic (and pragmatic) theories,

The doctrine that considers the data representation as representation of the physical and material reality, that is to say ”no information without physical implementation”, holds for a realist view of information. This is the view of Dretske and of the correlation paradigm in general. The doctrine that considers the data representation central for information, given that, by the principle, there not could be information without representation, but nevertheless rejects the thesis that information requires necessarily a physical implementation because there could be information as representation of a representation, holds for a idealist view of information. This is the view of Floridi 2 . Now, being information a subjective magnitude for the idealist, subjective is too the theory of justification that the idealist can offer for his epistemology. In fact **??**loridi (2006) offers a subjective theory of relevant information which implicitly is too his answer to the question of where information is: it’s in the subject.

Conversely, being information an objective magnitude for the realist, objective is too the theory of justification that the realist can offer for his epistemology. In fact **??**retske (1981) holds for an objective theory of relevant information and it’s too his answer to the question of where information is: it’s in the object or in the environment.

But I have other views and other fly to propose. At first I assume the Data Operational Principle (DOP), as outlined in the paragraph number three, as principle of information. Second I take the messages as information bearers, being this in completely agreement with the scientific practice, and therefore it is in the messages that the phenomenon of relevant information has to be searched. Third I propose two informational criteria for knowledge: one being relevance and, of course a message could be perfectly relevant and completely false or perfectly true and completely irrelevant; the other being effectiveness.

Outlining the criteria of relevance and effectiveness will be my task in what follows.

9 VI.

10 Relevant Information & the Praxiological Architecture of Attention

What Information Science reveals is very instructive, in fact being relevance a bit the question of ”where information is” it is therefore a bit the quest itself of the research, even if it is not its total story nor its ultimate answer. In fact relevance is the story of the research from the communicational side of it.

I’m holding for the thesis that if connectivity is the servomechanic criterion of communication, as it is and as I have explained in paragraph 1, relevance is the human criterion of it (communication). Sure the research is an exquisite human enterprise and relevance in scientific communication, if rightly questioned has to tell us how happens that, at certain time, limited and finite human beings as Archimedes for example, and Leonardo, Kepler, Galileo, Fermat, Galois, Mendel, Darwin, Laplace, Pasteur, Faraday, Thomson, Gibbs, Eddington, Dirac, Turing, Wiener and so forth, are able to open such a fruitful research lines. It is a bit the story of the relation of the finitude of human beings which yearn to be in contact with something opposed to their finitude and which has been experienced, from a good part of the good phenomenological continental philosophy, in the pessimistic perspective of a lack. Less pessimistic it is the outcome of the scientific thought. In fact the relation of human beings with knowledge is achieved in the time and experienced in the space, as cosmos, or order, or totality, or place.

It is not my attempt to give here an outline of the informational logic of scientific discovery and I postpone this outline to another article that for the moment is work in progress. What I will outline here is the criterion of relevance for humans and high level animals in respect to their practical and cognitive abilities.

In fact I’m holding for the thesis that relevance is the criterion of attention for humans and animals and that it is a criterion that emerges from joining the criteria of the communicational and the behavioral architecture. Not only that, in fact I’m holding for the thesis that attention itself is a phenomenon that emerges by joining the behavioral and the communicational architecture. As an example, for my behavioral perspective, the sense organs are communicational engines. They behave like channels that connect the environment (that is the source) to whom experiences that environment (that is the receiver). Now attention is a kind of sixth sense for humans and high level animals. Plants and low level animals as well as machines can be considered as communicational engines and as connected with their environment but they do not show nothing comparable to human attention and relevance. Consciousness, in this perspective has to be regarded as a communicational human emergent property from the complexity of the phenomenon of attention. But at the actual state of affair this can be taken only as an intuition which I will develop in other papers.

Attention, which operates to convey the relevant information from environment to whom experiences that environment for his practical tasks, is constituted by a couple of systems: input-output, and by a channel which in the behaviorist approach can be regarded as the sense organs by which information flows. Certainly I will not wear out the time of the reader proposing a technical definition of data, given that the interested reader can find a lot of definitions in Wikipedia and perhaps the better one is that of **??**loridi (2003a **??**loridi (, 2005)), the Diaphoric Definition of Data (DDD). What I will say is only that, being data those vehicles of representation, then, evidently, about data we have more than two thousand years of philosophical investigation.

Just this architecture holds for a praxiological approach to the study of attention. Our praxiological approach consists in observing the relation input-output of the system, that is in observing the behavior of the system, and consists in a classification of the attentive behavior.

Taking into account the architecture of the system, attention is classified in relevant/non-relevant. Relevant behavior is the connected and active behavior in which the object is the source of the output energy involved in a given specific reaction. That is to say that just what kind of relevant information may be picked up by depends upon just what kind of device the agent is and upon just what kind of organs the agent is equipped with. Plants and at some extent machines can be assumed as perceiving agents and their criteria is the connectivity. Attention with his criteria of relevance is a peculiarity of some high level complexity animals and human beings.

The relevant behavior, that is attention, is classified in purposeless/purposeful. For purposeful attention is meant that the attention is directed to a goal. In turn the purposeful attention is classified in feedback/non-feedback attention; and the feedback attention is classified in positive and negative feedback. Again the feedback purposeful attention can be classified predictive/non-predictive and the predictive attention can be focused at several degrees of complexity (fig. 11). In the above classification the first criteria is the peculiarity of the architecture of attention in respect to the behaviorist, the communicational and the computational architecture. It is obtained joining together the criterion of the architecture of behavior, that is activity, with that of communication, that is connectivity. Otherwise is quite intuitive that from an active and connected behavior emerges the attention. This is too a partial and non ultimate answer to the question of where information is: it is in the attention.

11 VII.

12 Effective Information & the Praxiological Architecture of Learning

I have remarked that the story of relevant information is only a bit the story of where information is.

To complete that story we have to take in consideration the phenomenon of effective information. This phenomenon, if not completely discarded by Information Science, it is at least very underestimated by that and moreover it seems that it is completely discarded by the contemporary philosophies of information.

In regard to Information Science there is to say that as far as the production of knowledge increases and the library becomes more and more comprehensive, in the virtual library where to the book is assigned an address as location as well as in the normal library where the books occupy more and more three-dimensional space, the work of the librarian in storing and retrieving information has to be efficient as well as the problem of searching ”where information is” becomes the question of searching where the effective information is.

Here I'm holding for the thesis that effectiveness is the other side, in respect to relevance, of the question of the research. In fact I'm holding for the thesis that if compatibility is the servomechanic criterion of computation, as it is and as I have explained in paragraph 2, effectiveness is the human criterion of it (computation). Sure the research is an exquisite human enterprise and effectiveness of scientific theories, if rightly questioned, has to tell us how happens that, at certain time, limited and finite human beings as Euclid for example, and Boole and Descartes and Newton and Maxwell and Boltzmann and Einstein and Heisenberg and Godel and Nash and so forth, discover those laws that compose the scientific theories and that can account for an infinite number of phenomena. As I have already said, it is not my attempt to give here an outline of the informational logic of scientific discovery but what I will outline here is the criterion of effectiveness for humans in respect to their practical and cognitive abilities.

In fact I'm holding for the thesis that effectiveness is the criterion of learning for humans and that it is a criterion that emerges by joining the criteria of the computational and the behavioral architectures. Not only that, in fact I'm holding for the thesis that learning itself is an architecture that emerges by joining the behavioral and the computational architectures.

Learning, which operates to acquire the effective information from the environment to the organizer of that environment for his theoretical and practical tasks, is constituted by a couple of systems: input-output, and by a channel which in the behaviorist approach can be regarded as the memory where information is processed and stored and from where information is retrieved.

We can show what learning is by joining the computational system (blue) with the behavioral system (red) to obtain the system (violet) of learning (fig. 12). Fig. 12 : The Architecture of Learning Just this architecture holds for a praxiological approach to the study of learning. Our praxiological approach consists in observing the relation input-output of the system, that is in observing the behavior of the system, and consists in a classification of the learning behavior. Taking in consideration the architecture of the system, learning is classified in effective/non-effective.

The first, most representative and yet actual model of effective information is the Turing Machine. When the idea of computing machine was proposed by Turing the idea was that of outlining an effective method or procedure or algorithm to establish if a problem has or not a solution. From the idea of Turing developed that big line of research that calls computation that roughly simplifying is all about calculus. In fact the formal definition of calculus is regardless of any single calculus and it is absolute, it calls computation. Computation in general has as its objects algorithms and is a theory of effectiveness because any algorithm is an effective procedure, that is a procedure that gives a solution after a finite number of steps. Now this is an intuitive definition and of course the notion of algorithm as well as the notion of effectiveness are human and intuitive notions. In any way today there are a dozen of formalisms, the most important being the Turing Machine, Recursion Theory and Lambda Calculus, stating that the intuitive definition and the formal or mechanical definition of algorithm coincide.

I have already sustained that the criterion of the Finite State Automata is compatibility and not effectiveness, contrary to what is actually believed in the scientific community. At this regard there is to note that the finite state automata are finite engines and they are completely decidable. Practically they output, after a finite number of steps, the answer to the computation and this cannot be otherwise given that they are finite machines. It is to note that being effectiveness a criterion or method to evaluate a procedure as such if it gives an answer after a finite number of steps than it is merely a misconception to elect effectiveness as criterion of the computation of the finite state automata given that they are completely decidable and finite engines and they could not be other than that. In other words, if effectiveness cannot be compared to uneffectiveness, as in the case of the finite state automata, than simply we could drop to speak of effectiveness for this machines and assume compatibility as their criterion.

The things complicate when we take in consideration the Turing Machine which, although being in itself nothing more than an automaton (even if it is the most powerful automaton), it can be thought as a purely abstract automaton with an infinite number of states, which already in the behaviorist approach of Turing's famous paper (1936) were regarded as the memory. Moreover the Turing Machine (M) can be thought as an Universal Turing Machine (UTM) which can be run with a representation of a M(n) and the string w to be processed by M(n). Practically the UTM takes as input every other M. And here the coolest and wonderful problem: the Halting Problem, that is: given an arbitrary Turing Machine M with input alphabet ? and a string w ? *, will the computation of M with input w halts? A solution to the Halting Problem requires a general algorithm that answers the halting question for every possible configuration of M and input string w. But it turns out that the halting question is undecidable. As a result the Halting Problem is undecidable and the Turing machine is semidecidable. That is there is not a procedure to determine if the Machine will halts. If the Machine finds a solution than it will halts, but if it does not finds one it does not halts and it will go searching for the eternity that solution. Turing idea of UTM was so powerful that it represents the architecture of the modern personal computers which are implementations of it (it is to note that in any implementation of UTM the memory is finite) and therefore they are semidecidable machines. It is to note also that the halting problem can be characterized in the field of computational complexity as the NP-complete problem K and certainly it is the first and most famous NP-complete problem. Now there is to appreciate the Church-Turing Thesis: there is an effective procedure to solve a decision problem if, and only if, there is a Turing Machine that halts for all input strings and solves the problem. There are many instances of the Church-Turing thesis and I have chosen the most general. It is worth enough to note that this thesis works and therefore has been accepted as definition of effectiveness by many, ( ) H even if not by all scientists. It works because we are facing really a problem of effectiveness given that the problem is to find a solution in a finite number of steps when we do not know if that solution exists and we know that the machine could work in a not finite time. And here the perfect link with cognitive science: supposed that human cognitive processes are effective, than the mind is a Turing Machine. This is the mechanist theory of mind.

Many have criticized this thesis and although in general the mechanism in science has meant progress in all fields of human investigation at least from the birth of modern science until today, nevertheless, the Church Turing Thesis which applies to mathematical objects and of course it is not provable but it is a very practical From my action-oriented perspective is strong enough to enlighten something that, it seems to me, really merits to be taken in consideration.

In fact, from the praxiological perspective, effectiveness has to do with action 3 rather than with representation and effective behavior is a matter of degree rather than a matter of all or nothing as it results by the representationalist view. The most part of plants, animals and machines can be assumed as computational agents and their criteria is compatibility. Some high level animals and machines can be assumed as low level learning agents and they can show effectiveness at some low degree. That is to say that just what kind of effective information can be managed depends upon just what kind of device the agent is and upon just what kind of memory the agent is equipped with.

From this praxiological approach learning is an architecture which emerges by joining together the architecture of behavior and that of computation, and its criterion, that is effectiveness, emerges by joining the criterion of computation, that is compatibility and its contrary, and that of behavior, that is activity and its contrary. Effectiveness for human beings is an active behavior in which the object is the source of the output energy involved in a given specific reaction. Effectiveness in machines is a passive behavior in which the object is not the source of the output energy involved in a given specific reaction. The effectiveness of machines and human beings turns not only of a different degree but also of a different level of the classification. In the passive behavior in fact the object is not the source of energy and all its energy in the output can be traced to the immediate input. That is because we should distinguish effectiveness and learning of the machines and humans. Human can show effectiveness in an active and I a passive way. In fact, at least from the great achievement of the father of evolution, Charles Darwin, we know that an action which at the beginning was voluntary and purposeful can be inherited from the next generations and becomes a reflex action which nevertheless does not lose its effectiveness. The inheritance of the machine simply means programmable and of course, after the human discover an algorithm or write a program, being it the Turing Machine itself or some less amazing program, it can be implemented or embodied and followed by a machine, but then it becomes a mechanical and reflex execution which nevertheless does not lose its effectiveness.

Subsequently, the effective behavior, that is learning, is classified in purposeless/purposeful. For purposeful learning is meant that the learning is directed to a goal. In turn the purposeful learning is classified in feedback/non-feedback; and the feedback learning is classified in positive and negative feedback. Again the feedback purposeful learning can be classified in predictive/non-predictive and thus focused at several degrees of complexity (fig. 13). Fig. 13 : Classification of the architecture of learning In the above classification the first criteria is the peculiarity of the architecture of learning. It is obtained joining together the criterion of the architecture of behavior, that is activity (and its contrary), with that of computation, that is compatibility. Otherwise is quite intuitive that from an active and compatible behavior emerges the learning. This is too the second and still not ultimate answer to the question of where information is: it is in the learning.

It is also understandable that a passive and compatible behavior could result effective. 3 Godel acknowledged already this. In fact Godel (1972a, page 306) in a remark published after his death writes (see also in Blass & Gurevich, pag. 6): "A philosophical error in Turing's work. Turing in his [On Computable Numbers], gives an argument which is supposed to show that mental procedures cannot go beyond mechanical procedures. However, this argument is inconclusive. What Turing disregards completely is the fact that the mind, in its use, is not static, but constantly developing, i.e. that we understand abstract terms more and more precisely as we go on using them, and more and more abstract terms enter the sphere of our understanding. There may exist systematic methods of actualizing this development, which could form part of the procedure. Therefore, although at each stage the number and precision of the abstract terms at our disposal may be finite, both (and therefore, also Turing's number of distinguishable states of mind) may converge toward infinity in the course of the application of the procedure."

On Praxiological Information conjecture, when applied to cognitive science becomes an empirical statement highly problematic and strongly dependent on the assumptions of the theorist.

Nevertheless if this kind of behavior can be considered as learning is still an open question for artificial intelligence.

13 VIII.

14 The Pluralism of Phenomena & the Integrative Epistemology of Information

At this point the spectrum of colors is complete. Now we have to make a synthesis of all the phenomena (colors) that I have outlined. We have to join the architectures of behavior, communication, computation, information, attention and learning. To do this we need simply to join together the architecture of attention and that of learning (being there all the colors of the Fig. 14 : The architecture of Knowledge That drawn above as knowledge is a prism with its three faces: interface, encoding and decoding. But this was already clear by the data Operational Principle. The reader will fully appreciate the effectiveness of the metaphor that I have exploited. In fact, standing to the theory of light, the white light is obtained when all the colors are projected through the prism and vice versa. Standing on this metaphor, knowledge is obtained when all the phenomena are encoded by the actions of human beings and vice versa.

Just this architecture holds for a praxiological approach to epistemology. Our praxiological approach consists in observing the relation input-output of the system that is in observing the behavior of the system and consists in a classification of the epistemic behavior.

Taking in consideration the architecture of the system, knowledge is classified in effective/non-effective and relevant/non relevant information. As a result, knowing is the relevant and effective behavior in which the object (human interface) is the source of the output energy involved in a given specific reaction. That is to say that just what kind of knowledge may be showed by the agent depends upon just what kind of device the agent is and upon just what kind of memory and sensory organs the agent is equipped with. Animals, plants and machine can be assumed as communicational and computational agents and their criteria are connectivity and compatibility. Knowledge with his criteria of effectiveness and relevance is a peculiarity of human beings and may be some high level animals.

It follows that the relevant and effective behavior, that is knowledge, is classified in purposeless/purposeful. For purposeful, effective and relevant behavior is meant that knowledge is directed to a goal. In turn the purposeful knowledge is classified in feedback/non-feedback; and the feedback knowledge is classified in positive and negative feedback. Again the feedback purposeful knowledge can be classified predictive/non-predictive and thus focused at different degrees of complexity.

In the above classification the first criteria are the peculiarity of the architecture of knowledge. They are obtained joining together the criterion of the architecture of attention, that is relevance, with that of learning, that is effectiveness. Otherwise is quite intuitive that from an relevant and effective behavior emerges the knowledge. This is too the complete and ultimate answer to the question of where information is in human beings: it is in the knowledge.

The following criteria are the usual criteria of the praxiological kind. Otherwise it is quite intuitive that knowledge is directed to a goal: wisdom; that it benefits of some negative feedback in the process of achieving its goal; and that it manifests some degree of predictivity: forecasting. IX. ( ) H spectrum) and we obtain the architecture of knowledge (fig. 14). In fact what is knowledge, from a fully operational and action oriented perspective, if not attention and learning? [1] [2] [3] [4] [5]

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Figure 1: Fig. 2 :

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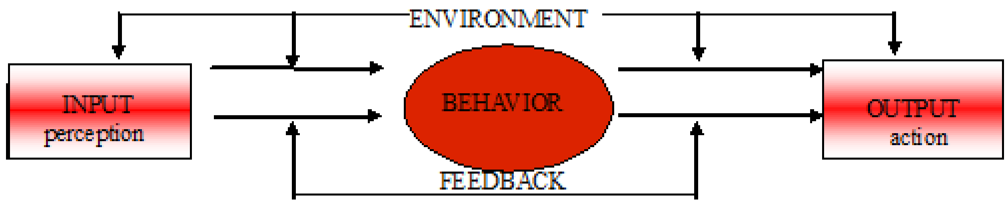
[3] 20 2

[4] 20 2

[5] 20 2 43 manifestations of relevance. Journal of the American Society for Information Science and Technology,



1

Figure 2: Fig. 1 :

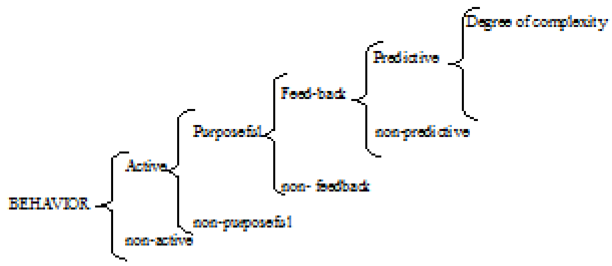


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Figure 3: Fig. 3 :

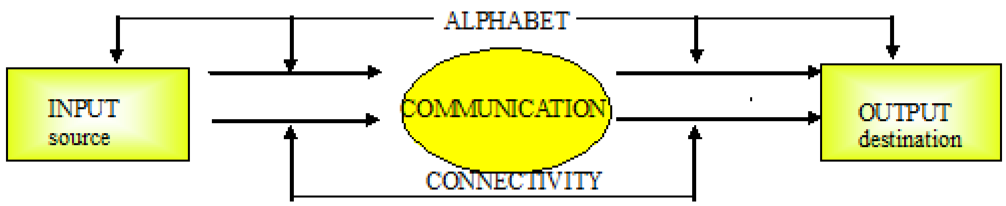

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Figure 4: Fig. 4 :

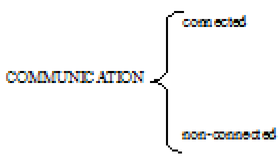

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Figure 5: Fig. 5 :

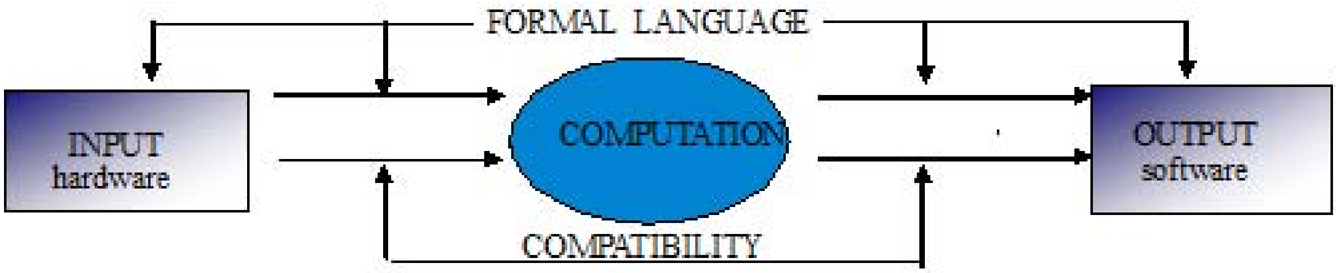

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Figure 6: Fig. 8 :

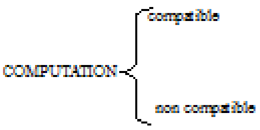

Figure 7:

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Figure 8: Fig. 10 :

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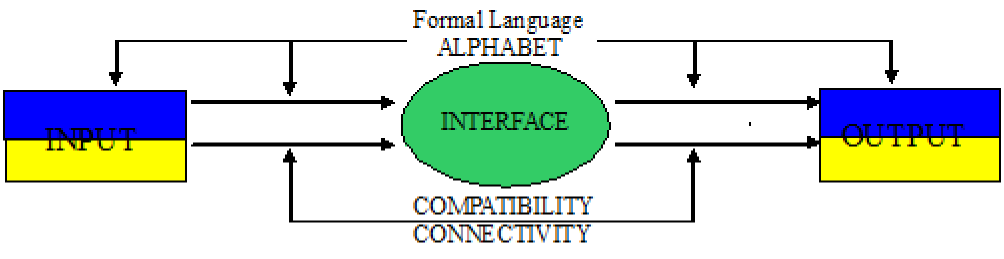
Figure 9: 2



11

Figure 10: Fig. 11 :

[Philosophical Quarterly] , *Philosophical Quarterly* 32 p. .

[Behaviour, Purpose and Teleology. Philosophy of Science] , *Behaviour, Purpose and Teleology. Philosophy of Science* 10 p. .

[Rosenblueth et al. ()] , A Rosenblueth , J Bigelow , N Wiener . 1943.

[Wiener ()] , N Wiener . 1948. Cybernetics. CA, Mass: MIT Press.

[Bessett ()] 'A Brief History of Servomechanisms'. S Bessett . *IEEE Control Systems* 1994a. 14 p. .

[Hodges ()] *Alan Turing: the enigma*, A Hodges . 1983. (Vintage edition)

[Blass and Gurevich ()] 'Algorithms: A Quest for Absolute Definitions'. A Blass , Y Gurevich . *Bulletin of European Association for Theoretical Computer Science* 2003. 2003. 81.

[Von Bertalanffy ()] 'An outline of General system theory'. L Von Bertalanffy . *British Journal of Philosophy of Science* 1950a. 1 p. .

[Nelson ()] 'Church"s Thesis and Cognitive Science'. R Nelson , J . *Notre Dame Journal of Formal Logic* 1987. 28 (4) .

[Godel ()] *Collected Works*, K Godel . 1990. Oxford University Press. II.

[Copeland (ed.) ()] *Computation. The Blackwell Guide to the Philosophy of Computing and Information*, J Copeland , B . L. Floridi (ed.) 2003. Oxford -New York: Blackwell. p. .

[Wiener ()] *Cybernetics or Control and Communication in the Animal and the Machine*, N Wiener . 1961. Cambridge, Mass: MIT Press. (2nd ed.)

[Conway and Siegelman ()] *Dark Hero of the Information Age: In search of Norbert Wiener the father of Cybernetics*, F Conway , J Siegelman . 2005. New York; Basic Book.

[Frank ()] *Epiphenomenal Qualia*, J Frank . 1982.

[Dretske ()] *Explaining Behavior*, F Dretske , I . 1988. Cambridge, Massachusetts: The MIT Press.

[Chalmers ()] 'Facing Up to the Problem of Consciousness'. D Chalmers , J . *Journal of Consciousness Studies* 1995. 2 (3) p. .

[Darwin ()] *From So Simple a Beginning. The Four Great Books of Charles Darwin*, C Darwin . 2006. Wilson, New York & London: W. W. Norton & Company.

[Wiener ()] *God and Golem, Inc.: Comment on Certain Points Where Cybernetics Impinges Religion*, N Wiener . 1964a. Cambridge, MA: MIT Press.

[Hofstadter ()] *Godel, Escher, Bach: An Eternal Golden Braid*, R D Hofstadter . 1979. New York: Basic Books.

[Floridi ()] 'In defence of the veridical nature of semantic information'. L Floridi . *European Journal of Analytic Philosophy* 2008. 2007. 3 (1) p. .

[Dreyfus ()] 'Intelligence without representation -Merleau-Ponty"s critique of mental representation. The relevance of phenomenology to scientific explanation'. H Dreyfus . *Phenomenology and the Cognitive Sciences* 2002. 2002. 1 p. .

[Lane ()] *Mathematics Form and Function*, Mac Lane , S . 1986. New York, Berlin, Heidelberg, Tokyo: Spring-Verlag.

[Kirk ()] *Mental Machinery and Godel. Synthese: 66*, R Kirk . 1986. p. .

[Gagliasso (ed.) ()] *Metafore e realta': il caso del concetto di informazione*, E Gagliasso . B. Continenza & E. Gagliasso. Milano: Franco Angeli (ed.) 1998. (L'informazione nelle scienze della vita)

[Turing ()] 'On Computable Numbers, with an Application to the Entscheidungsproblem'. A Turing , M . *Proceedings of the London Mathematical Society* 1936. 42 p. .

[Noe and O"regan (ed.) ()] *On the brain-basis of visual consciousness: A sensorimotor account*, A Noe , J O"regan , K . Noe, Alva Thompson, Evan (ed.) 2002. Cambridge, MA, US: MIT Press. p. . (Vision and mind: Selected readings in the philosophy of perception)

[Huxley (ed.) ()] *On the Hypothesis that Animals are Automata, and its History. The Fortnightly Review, n.s.16:555-580*, T H Huxley . Thomas H. Huxley (ed.) 1874. 1898. New York: D. Appleton and Company. (Reprinted in Method and Results: Essays by)

[Capurro ()] 'Past, present and future of the concept of information'. R Capurro . *Triple C Journal of Philosophy* 2009. 2009. 7 (2) p. . (special issue: What is really information)

[Zahavi ()] 'Phenomenology and the project of naturalization'. Dan Zahavi . *Phenomenology and the Cognitive Sciences* 2004. 3 p. .

[Pierce ()] J R Pierce . *An Introduction to Information Theory: Symbols, Signals & Noise*, (New York) 1980. Dover Publications. (2nd edition)

[Saracevic ()] ‘Relevance: A Review of and a framework for the thinking on the notion in information science’. T Saracevic . *Journal of the American Society for Information Science* 1975. 26 (6) p. .

[Saracevic ()] ‘Relevance: A review of the literature and a framework for thinking on the notion in information science. Part III: Behavior and effects of relevance’. T Saracevic . *Journal of the American Society for Information Science and Technology* 2007. 58 (13) p. .

[Saracevic ()] ‘Relevance: A review of the literature and a framework for thinking on the notion On Praxiological Information ©’. T Saracevic . *Global Journals Inc. (US)* 2007. 2013. 58 (3) p. .

[Monod and Francois ()] ‘Teleonomic Mechanism in Cellular Metabolism, Growth, and Differentiayion’. J Monod , J Francois . *Cold Spring Harbor Symposia on Quantitative Biology* 1961. 26 p. .

[Marijuan ()] ‘The Advancement of Information Science. Is a New Way of Thinking Necessary?’. P Marijuan , C . *Triple C Journal of Philosophy* 2009. 2009. 7 (2) p. . (special issue: What is really information)

[Von Neumann ()] ‘The Computer and the Brain’. J Von Neumann . *New Haven and London*, 1958. 2000. Yale University Press. (Second ed.)

[Shannon ()] ‘The Mathematical Theory of Communication’. C Shannon , E . *r in information science. Part II: nature and 37*, C E Shannon, W Weaver (ed.) (Urbana) 1948. 1948. University of Illinois Press. 27 p. . (The Mathematical Theory of Communication)

[Nauta ()] *The Meaning of Information. Mouton: The Hague*, D Nauta . 1972.

[Florio ()] ‘The notion of ”being informative” & the praxiological information perspective on language’. A Florio . *Triple C Journal of Philosophy* 2009. 2009. 7 (2) p. . (special issue: What is really information)

[Chomsky ()] ‘Three Models for the description of Languages’. N Chomsky . *IRE Trans. On Information Theory* 1956. 2 p. .

[Floridi ()] *Understanding Epistemic Relevance. Erkenntnis, 69.1*, L Floridi . 2008. p. .

[Copeland ()] *What is Computation? Synthese*, J Copeland , B . 1996. 108 p. .

[Nagel ()] ‘What is to be like a bat?’. T Nagel . *Philosophical Review* 1974. LXXXIII p. .

[Peirce (1905)] ‘What Pragmatism Is’. C Peirce , S . *The Monist* Philip P. Wiener (ed.) 1905. April 1905. 1966. Dover Publications, inc. 15 p. . (Reprinted in ”Charles S. Peirce: selected writings)

[Wiener ()] N Wiener . *The Human Use of Human Beings: Cybernetics and Society*, (London) 1954. Free Association. (2nd ed)