INFORMATION SCIENCE: BRIEF REVIEW OF SOME IMPORTANT CONTRIBUTIONS OF THE AUTHOR

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Abstract. *The humankind leadership by means of the information knowledge was known even from the antique times (see e.g. John 1:1). The computers appearance at the middle of the 20th century strengthened even more the dominant role of Information, Not only that this is present in all types of processes (human: cultural, scientific, technical, of trade, etc. and biological, in the field of living beings), but – additionally – the information initiates, sustains and ensure the success (through favorable results) of all these processes. As we have pointed out already, the computers represent only a tool for the information processing and transmission. Given being that usually the studies concerning the history of the Information Science and Technology refer mainly to the techniques intended to the transmission and use of Information, the present work focuses on the: a) detailed description of the basic aspects (statistical, structural-syntactic, semantic, of accuracy remained for the complex systems, pragmatic - of action, teleological-apobetic) of the Information science, b) main contributions from the last 100 years, c) Romanian contributions, of the fellows of the Academy of Romanian Scientists, particularly.*

Keywords: Shannon's Information Theory, Syntax, Semantics, Information Accuracy, Pragmatics, Apobetics

1. Introduction

It is well known that any idea, any device, any installation, and even any living being involve some specific information (see e.g. James Gleick [1a]). Referring to the mass/energy – information relationship, the Princeton's Physics professor John Archibald Wheeler (1911-2008) launched (in 1989) his famous saying "It is bit" [1b]. Taking into account that "It" could be anything, one arises presently the question: Could the information be even more fundamental (basic) for all our activities than the matter itself?[+] Given being the information is an extremely complex concept, involving various types of expression (e.g. by means of the human speaking, nervous activity processes, hereditary features transmission, economical processes, different types of electronic communications, etc.), the general description of Information represents a very difficult task, a true "puzzle". In such conditions, the easiest beginning of the Information description is represented by its quantitative (statistical) evaluations, of the type of Claude Shannon's (1916-2001) [2] achievements.

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[+]*Wheeler has written (1989) even: "It from bit" [1a]!*

As it concerns the qualitative features of information, excepting its accuracy left by the studied problem complexity, all other qualitative information aspects (syntax, semantics, pragmatics and apobetics[1]) were considered and thoroughly studied by Werner Gitt's synthesis [3][2]. Unlike the usual monographs intended to the history of the Information Science and Technology (see e.g. [4], for the Romanian specialty literature), the present study will focus on the Information aspects (see above) and not on its domains (fields), on the used devices for its obtainment, etc.

2. Scientific Studies concerning the Statistical, Syntactic, "Anti" (destroyer of) Syntax, Accuracy left by Complexity and Pragmatic Aspects of Information prior the Shannon's communication ("information") theory [2a]

Taking into account the huge number of the scientific information applications (and its tremendous growth rate[3]), even prior to the Shannon's communication theory [2a] printing, it is absolutely necessary to select the most representative works corresponding to the main information features (aspects).

2.1. Statistical description of information

It seems that the notion of "information amount" was introduced by the American researcher Ralf Vinton Lyon Hartley [5]. Among the first Romanian contributions to the statistical aspect of the language (and information, implicitly), we have to mention the Dimitrie Macrea's work [6].

2.2. Syntactic aspects and "Anti-" (destroyers) of Syntax works

Since the qualitative (the syntactic and semantic, mainly) features of Information cannot be overlooked, the British scientist Rudolf Carnap (1891-1970) considered [7] between 1935 and 1938 these aspects, corresponding to the language. Besides the human languages, there are also some systems of sounds which can transmit information, as: a) the birds sounds, that can communicate even certain structured (by means of some specific syntax and semantics, as for the China titmouse, see the findings of certain Swedish, Japanese and Swiss [14a] researchers) information, b) the music, which can transmit even (by means of its structure) some feelings [14b], [14c].

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[1]Apobetics = denomination introduced by W. Gitt [3] for the information aspect corresponding to the Greek word "apobeinon" (= result; success, conclusion).

[2]According to W. Gitt: "no science, apart from the communication technology, should limit itself to just the Claude Shannon's statistical level of information", adding also: "Several authors repeatedly pointed out that Shannon's definition of information encompasses only a very minor aspect of information" [3], p. 50.

[3]According to [3], p. 161: "At present, the total volume of knowledge is doubled every seven years. For electrical technology, this period is five years, and it is even less in the case of information technology. … It becomes very difficult, and sometimes impossible, to find relevant information in the present knowledge explosion".

We have to mention also that the British mathematical physicist Douglas Rayner Hartree (1897-1958) has introduced – by means of the work [8a] – the so-called system of "atomic" units, inside whom all physical quantities have the same dimension (**1**)[1].

This units system has the: (i) advantage of a great simplification of the physical relations corresponding to highly complex systems (as that of electrons inside solid bodies), paving also the way to some computer languages (as Fortran ≡ Formula Translations), but also the: (ii) strong disadvantage to impede (hinder) the check of the correctness of physical relations by means of the comparison of the physical dimensions (possibly different) of some of their terms [acting so as "anti-" (distroyer) of the Syntax aspect].

2.3. Semantic aspects of Information

We have to mention that the works [7] refer also to the semantic aspect of the Information (see also [9], p. 234).

Given being the main goal remains – for the scientific works, inclusively – the applications, sometimes the solution of some rather intricate problems needs two steps: (i) one devoted to the understanding (*semantics*) of the complex aspect of the studied topics, and: (ii) the second one, acting to "level" the way from the understanding to the effective application (*pragmatics*).

Such an example for the evaluation of the crystalline lattices parameters, corresponds to the derivation of the Brag and Bragg law [10], which represents the necessary (for understanding) level, but not sufficient for this task solution.

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An even more complex study, intended to the understanding of the inter-links of some distinct scientific (and information) fields, as those of the animal organisms states and of the phonic processes, respectively, was achieved [11] by the Romanian researcher Ştefan Odobleja (1902-1978), who was so a predecessor (even in an enlarged version) of Cybernetics [15].

2.4. Accuracy (left by Complexity) aspects

Besides the well-known source of inaccuracies – the experimental errors, the used methods of data processing could contribute also significantly to errors by means of some numerical phenomena, particularly. The basic work of R. Courant, K. Friedrichs and K. Lewy [12] has identified and described in detail the main types (instability, non-convergence, dispersion) of the numerical phenomena met in the frame of the FD (Finite Differences) simulations of the wave propagation in ideal media.

[1]See also the monograph of L. A. Sena [8b].

2.5. Pragmatic aspects of Information

While the Bragg and Bragg's law [9] of X-rays diffraction of crystals ensured the understanding of this scientific problem, but not the direct application to the evaluation of the crystalline structure parameters (periods, angles between the periodicity directions, etc), the elaboration by Paul Peter Ewald (1888-1985) of his geometrical "construction" procedure [13] allowed the complete solution of this scientific task.

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Despite its outstanding and well-known results of the statistical Shannon-Weaver's [2] theory of communications (named later "the information" theory), this mathematical description has obviously narrow limits, known to both its founders[1], and to other contemporary scientists [9][2]. That is why the efforts to elaborate and consolidate a qualitative (semi-quantitative) theory of information continued endlessly, their most significant achievement (synthesis) being that of Werner Gitt's [2] monograph.

3. Between the Shannon-Weaver's Statistical "Information" theory [2] and the first works [35] of W. Gitts' qualitative information theory

Almost concomitantly with the Claude Shannon's first papers [2] on the communication theory, it was printed the book [15] of the MIT researcher Norbert Wiener (1894-1964), who was so founding the inter-linking (of communications, at the level of human beings and of machines, respectively) field of *Cybernetics*.

Few years after the printing of Shannon's [2a] works, there were elaborated the works [16] of the Russian mathematician Alexandr Jakovlevitch Khinchin (1894-1955), concerning the mathematical foundations of the Information Theory.

Only 5 years after the printing of the Claude Shannon's first papers [2] on the communications theory, the Carnap's works [7] were followed by the Bar-Hillel study [17] on certain Syntax and Semantics aspects of Information.

Among the main Romanian contributions to Linguistics (and Information, implicitly), we will mention the works [18], as well as those cited by the S. Marcus' monograph [9] (p. 232) referring to the statistical description of the Romanian language [19]-[22].

The first Romanian contributions to the statistical theory of information were due to Professor Silviu Guiaşu [23].

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[1]According to Warren Weaver [13]: "Two messages, one of which is heavily loaded with messages and the other which is pure nonsense, can be exactly equivalent as regards (the statistical; our note) information.

[2]By means of the statistical Shannon's description, the information concept is considerably impoverished [8], p. 234.

Inside his papers [24], the American mathematician J. Lambek enounced the following interesting question: Could it be checked the correctness of a phrase by means of a calculation accomplished on certain types associated to the words of a natural language, as it is done in Physics by the comparison of the physical dimensions of the terms of a certain relation? In connection with the works [24], and – as a reaction to the "anti-syntactic" works generated by [8] for different complex systems – the work [25] studied the true syntax and semantics of the basic relations describing the continuous X-ray radiation.

The necessity to study the information corresponding to the complex systems from nature sciences and medicine, especially, was underlined by the German cyberneticist Bernhard Hassenstein, who rightly has found [26] (relative to the Shannon's "information" theory) that: "It would have been better to devise an artificial term, rather than taking a common word and giving it a completely new meaning" [3]. Starting from the findings of the paper [26], the work [27] studied one of the simplest complex system (a mixed manganese-zinc ferri-magnetic material) pointing out some essential features of this compound, as the presence of some: a) *power laws*, b) *phase transitions*, during a sufficiently slow heating of this material.

The narrow limits of the Claude Shannon's theory of "information" were pointed out also by the study [28]: "The classical theory of information can be compared to the statement that one kilogram of gold has the same value as one kilogram of sand".

The first monograph on the Information transmission theory, intended to the instruction of the Romanian specialists in the field of Electronics and Telecommunications was achieved by Professor Alexandru Spătaru [29].

The binary codifying of information and its storage by means of holograms was studied in the frame of P. Sterian's work [30].

As it is known, the complexity of some studied systems induces certain errors or – at least – uncertainties about the values of their parameters and of the co-relations joining them. The remaining (left by the complexity) accuracy of the measured values of their parameters and of the corresponding co-relations was studied by the works [31].

The time structure of the information, the entropy and the open complex systems evolution was studied in the frame of E. von Weiszäcker's monograph [32], being also found that: "The reason for the useless of Shannon's theory in different sciences is frankly that no science can limit itself to its syntactic level", while the strong co-relation between the physical entropy, information and objectivity was pointed out by the F. Sösemann's study [33a]. The same result was obtained by the German biologist G. Osche [33b], namely that the Shannon's theory is unsuitable from a biologic point of view.

The extremely strong co-relation between the structures (notions and methods) of the nature sciences and the Information was examined in detail by the studies [33a], [34] and [35].

The pragmatic aspect of information was illustrated in the frame of the work [36], by means of the use of the electro-optical modulation to measure some electrical quantities with very large values, as also by the works [37] referring to the study of the mesophasic molecular structure of nematic liquid crystals by means of the optical microscopy in polarized light.

Another example of this kind refers to the pragmatic use of the acousto-optical information for the study of the laser mode conversion [38].

A synthesis of the most important results of the optical technologies of information, as well as of some essential aspects (structural, of understanding and pragmatic, mainly) of the Information science was achieved in the frame of prof. Sterian's monograph [39].

3. Scientific works following the printing of the first works [35] of the Gitt's semi-quantitative theory of Information [3]

As it was already mentioned above, while the statistic aspect of Information is amply studied in the frame of the books of Mathematics of Information (as [16]), Informatics and even in some books intended mainly to the qualitative aspects of Information [3], this study will focus on the scientific description of these qualitative features of Information.

3.1. The syntactic (structural) aspect

Following the ideas of the American mathematician J. Lambek [24], it is possible to induce a certain structure (and a corresponding syntax) in the frame of the huge amounts of specific information by identifying some types associated to the components of the considered description.

While some general modeling of certain specific complex systems (which prolong up to the pragmatic-apobetic aspects) were studied by the monographs [40], [41], the modeling of the free-scale processes was considered by prof. Viorel Păun [42], that of the dissipative systems in quantum engineering by the work [43], being studied also even some didactic presentations of certain modeling methods [44].

Among the most important such structural methods, we will examine:

a) The Cybernetics, introduced (using the Greek word *kybernetike*, see [4], p. 254) even by the well-known scientist André Marie Ampère (1775-1836) in the frame of his treatise "Study of the philosophy of sciences" (in French). A detailed review of the essential contributions in this scientific field was achieved in the frame of the monograph [4], p. 255-258.

b) The solitons, introduced mainly by the classical works of J. S. Russell [45], V. J. Boussinesq [46], and D. J. Korteweg – G. de Vries [47], followed by the newer (contemporary) contributions of N. J. Zabusky and M. Kruskal [48], A. Hasegawa (with additional implications to the pragmatic-apobetic levels) [49], V. Chiroiu and L. Munteanu [50], M. Scalerandi, P. P. Delsanto et al. [51] (related also to the accuracy-numerical phenomena aspects), the treatise [52] of L. Munteanu and Șt. Donescu (with implications to the pragmatic-apobetic levels), as well as the work [53] of drs. A. D. Petrescu, A. R. Sterian and P. E. Sterian.

The distortions of KdV soliton pulses intervening during their propagation were studied by I. Apostol et al. [54].

c) The fractals, introduced by the French mathematician Benoît B. Mandelbrot [55]. Among the later most important contributions, we will mention the monograph of Jean-François Gouyet [56], the synthesis works of prof. Mircea Olteanu [57], prof. R. Dobrescu et al. [59], respectively, as well as the contribution of dr. Violeta Liliana Constantin [60].

d) The scale-free networks, introduced firstly by P. Erdös, A. Rényi [61], B. Bolobás [62]. The main applications of the scale-free networks were reported by A. L. Barabási and his collaborators [63], by prof. Radu Dobrescu et al [64], as well as in the frame of prof. Radu Ursianu's synthesis [65].

e) The complex models for Adaptive Systems, Biology and Medicine: We consider as the most representative, the works of J. Neyman et al. [66], and P. Jagers [67], as well as those of acad. Ion Dumitrache [58], of professors Cătălin Vasilescu [68] and Radu Dobrescu [69].

f) Modeling of some special information transmission processes:

The quantum modeling of the telepathy processes was examined by Professors Paul E. and Andreea Sterian [70].

3.2. The accuracy (left by Complexity) aspect

As it was shown already, besides the usual experimental inaccuracies intervening in the evaluation of different parameters, another importance source of inaccuracies correspond to the numerical phenomena intervening in the used mathematical methods, especially when the computers are used for the description of some complex systems. Following the crucial work of Courant, Friedrichs and Lewy [12], other typical distortions introduced by the Finite Difference (FD) simulations of pulses propagation were pointed out by the works [72], [72] of prof. Pier Paolo Delsanto (Politecnico di Torino) and of his collaborators, the most important referring to the opposite (relative to the simulated pulse) distortion, which follows immediately this simulated pulse.

A detailed analysis of the most important numerical phenomena (instability, non-convergence, dispersion, distortions) intervening in the FD simulations of the pulses propagation through ideal media was reported in the frame of the works [73], [74], while the possibility to improve the accuracy of FD descriptions by reducing the impact of numerical phenomena was studied by the work [75].

The relationship between the Numerical Artifacts and the Numerical Phenomena for different Complex Simulations was examined by the work [76], while the applications of the hierarchies emerging from different Numerical Phenomena were studied in the frame of work [77].

3.3. The pragmatic aspect

First of all, we have to choose a reference topic of maximum interest for the field of Information. Given being the strong interweaving of the aspects of Information Science and Information Technology, we selected the topic of Charge Coupled Devices (CCDs), with outstanding results for the detection of the weak light sources (as those from Astronomy), as representative for our goals.

In this aim, the studies intended to the MOS (and CCDs, particularly) devices characterization achieve an extremely useful action for their subsequent use. Among the main accomplished such studies we can cite the:

a) works [78], [79] of Professors Gheorghe Brezeanu, and Mircea Bodea, respectively, concerning some MOS devices, as well as the works of Professors Erik Bodegom and Ralf Widenhorn concerning the: (i) Meyer-Neldel rule [80], (ii) temperature dependence of the dark current in CCDs [81], (iii) study of some devices using CCDs [82],

b) study [83] referring to the identification of the main types of defects present in the CCDs semiconductor materials, and of their use for particle detectors, etc.

3.4. The teleological (apobetic) aspect

a) Achievements referring to Nano-sensors (CCDs, particularly)

A representative example of nano-sensors achievements and studies is given by the works [84] of dr. Cornel Cobianu and his collaborators

As it is known, there is a huge number of scientific and technical works reporting their main results about some achieved and applied CCDs. That is why, we will prefer to cite some corresponding synthesis treatises, as the specialty monographs [85a] and [85b], respectively.

b) Academic learning materials

A synthesis monograph about the main challenges of the present Information Society was elaborated by acad. Florin Gh. Filip and et al. [86].

The study of the polyphonic collaborating learning was achieved by prof. Şt. Trăuşan-Matu and his collaborators [87].

While a general study of the Information applications in Physics was achieved by the treatise of professors Eric Bodegom and Dan Iordache [88], the use of the opto-electronic systems for the night view was analyzed by the academic course of dr. Cătălin Spulber and his collaborators [89].

c) General Information about some inventing activities

The author considers as extremely useful the information given by the great American inventor R. J. LeTourneau in frame of his autobiography [90].

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