The Digital World – Essence and Dualism

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Резюме: *Този текст (част от докторска дисертация в развитие) се фокусира върху съвременните предизвикателства пред философията, в процеса на синхронизиране на концепциите с бурно развиващите се изследвания на дигиталния свят. Отправна точка са виждан‌ията на Р. Декарт и Г. Лайбниц, заявени преди векове, но валидни в значителна степен и днес. Коментарът е от позиция на физикалиста, а анализът включва човешкия бинарен подход, онтологичните аспекти на компютърните програмни езици, както и философията във взаимоотношенията хардуер-софтуер.*

Ключови думи: *битове, данни, информация, фрактали, въображение, мислене, съобразяване, език, компютър, мозък.*

Abstract: *This text (a part of a Doctoral Thesis development in progress) is focused on the recent challenges before philosophy, based on the necessity to synchronize our contemporary concepts with the latest outcomes in the studies of the Digital World. The key perspective is grounded on what R. Descartes and G. F. Leibniz foresaw centuries ago. The standpoint is physicalist and the analysis considers: the human Binary Approach and Binary System, the ontological aspects of the computer programming languages, and the philosophy within the hardware and software correlation.*

Key words: *bits, data, information, fractal, imagination, thinking, reasoning, language, computer, brain*.

In 1637 Rene Descartes concluded:

"The long chains of simple and easy reasonings by means of which geometers are accustomed to reach the conclusions of their most difficult demonstrations, had led me to imagine that all things, to the knowledge of which man is competent, are mutually connected in the same way, and that there is nothing so far removed from us as to be beyond our reach, or so hidden that we cannot discover it, provided only we abstain from accepting the false for the true, and always preserve in our thoughts the order necessary for the deduction of one truth from another."[1]

Further he added:

"I had become aware, as early as my college days, that no opinion, however absurd and incredible can be imagined, that has not been held by one of the philosophers."

[1] Rene Descartes, *Discourse on Method*, 1637 (New York, Classic Books America, 2009).

In fact man is not often absolutely sure of his views or conclusions, so a definite “Yes” or “No” is frequently qualified. Therefore, the bits’ essence as pure “Yes” or “No” raises a set of questions in a philosophical discourse. Obviously, the challenge of “No, but…” and “Yes, in case…” in a digital/informational context is much deeper than Descartes’ famous conclusion “Doubt is the origin of wisdom,” and the problem refers directly to both:

- The level of categorical concluding that mankind has the capacity to provide in general, depending on the discourse. For instance, one and the same chemical reaction brings different meanings to an engineer, a medical doctor, and a philosopher, and
- The level of personal uniqueness and the individual viewpoint regarding the share of the data flow which anyone is capable of capturing and processing. For example, there may be many observers of a concrete experiment with roughly similar intellectual and educational backgrounds, but just a few of them or perhaps only one, will reach an important conclusion.

So, any answer of a pure “No” or “Yes” always involves an interpretative element and in general, one can think about a lot of questions which can have proper positive and negative replies which are satisfactory but to different agents. Tappenden applies this perspective even from a purely personal perspective:

> "I" live in all branches and have "distinct experiences" in different "superslices", and use "weight of a superslice" instead of measure of existence.
> Faced with an array of weighted superslices as part of myself ... what choice do I have but to assign an array of attitudes, degrees of belief, towards the experiences associated with those superslices.”[2]

In 1988 this peculiarity of our species, combined with the quantum level uncertainty (which contemporary physics had already studied at that time), brought Albert and Loewer[3] to propose the Many Worlds Interpretation (MWI) in which the different worlds are only in the minds of sentient beings. In addition to the quantum wave of the universe, they postulate that every sentient being has a continuum of minds. Whenever the quantum wave of the universe develops into a superposition containing states of a sentient being corresponding to different

[2]Paul Tappenden, *Identity and Probability in Everett's Multiverse* (Oxford, British Journal for the Philosophy of Science 51, 99-114, 2000) available also in PDF at http://bjps.oxfordjournals.org/content/51/1/99.full.pdf+html
[3]David Albert and Barry Loewer, *Interpreting the Many Worlds Interpretation, Synthese* (Cambridge, MA, Harvard University Press, 1988) 195-213.

perceptions; the minds of this sentient being evolve randomly and independently to mental states corresponding to these different states of perception (with probabilities equal to the quantum probabilities for these states).

This trend had many opponents, criticizing with numerous arguments the quantum aspect of the problem specifically based on the newest facts noted by scholars in physics today. For example, in 2012 Michael Cuffaro claims:

> “The many worlds explanation of quantum computation is not licensed by, and in fact is conceptually inferior to the many worlds interpretation of quantum mechanics from which it is derived. I argue that the many worlds explanation of quantum computation is incompatible with the recently developed cluster state model of quantum computation. Based on these considerations I conclude that we should reject the many worlds explanation of quantum computation.”[4]

On the other hand, the introduction of too much physics to purely subjective issues was also severely criticized, particularly in relation to the social aspects of the problem as well as regarding the notion of truth in reference to uncertainty. As, for example, Brown argues:

> "When we can no longer declare what is True in the registers of morality, cosmology, or politics, the spaces evacuated by such Truths do not remain empty but, to the contrary, grow crowded with technical truths -instrumentalist discourse dangerously cut loose from regulating values and substantive, accountable aims"[5]

However, despite this ongoing discussion information technology kept developing and growing rapidly thus becoming engaged within various aspects of our everyday life without which nowadays we cannot imagine living. One can hardly think about a young person living in most regions of the earth who does not use a cell phone or the Internet. Therefore, the Information Theory, based on the bits’ “Yes” or “No” concreteness and clear mathematical logic attracted a wide segment of defenders in philosophy. As Adriaans puts it:

> Information is a recognized fundamental notion across the sciences and humanities, which is crucial to understanding physical computation, communication, and human cognition.

[4] Michael E. Cuffaro, *Studies in History and Philosophy of Science,* Part B 43 (1) *Many worlds, the cluster-state quantum computer, and the problem of the preferred basis* (New York, Sprinder-Verlagm 2012) 35-42, available also in PDF at http://www.sciencedirect.com/science/article/pii/S1355219811000694

[5] Wendy Brown, *Feminist Hesitations, Postmodern Exposures, Differences*, (Leeds, Sage Publications, Theoretical Criminology and Criminal Husyice journals, 1 - February 1997) 25-51.

> Descartes directly argues against the possibility of artificial intelligence and it even might be interpreted as arguing against the possibility of a universal Turing machine: reason as a universal instrument can never be emulated in space. This conception is in opposition to the modern concept of information which as a measurable quantity is essentially spatial, i.e., extensive (but in a sense different from that of Descartes).
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> Philosophically more relevant is the work of Leibniz (1646–1716) on a so-called *characteristica universalis*: the notion of a universal logical calculus that would be the perfect vehicle for scientific reasoning. A central presupposition in Leibniz' philosophy is that such a perfect language of science is in principle possible because of the perfect nature of the world as God's creation (*ratio essendi* = *ration cognoscendi,* the origin of being is the origin of knowing).[6]

Obviously, if willing to discuss the challenge of "No, but…" and "Yes, in case" issue, one should start with a deeper observation on the "Yes" or "No" binary system on which all data and computational processes are based.

Philosophical analysis of the Binary Approach and Binary System. The philosophical consequences of Benoit Mandelbrot's Fractal Theory.

The binary system is simple, clear and logical mathematical method. Some scholars recognize it as a mathematical instrument the same as a mathematical equation. They have their opponents too. As noted in the Introduction, I will not get involved in the mathematicians' discussion but I will focus on their product in a philosophical discourse.

Contemporary philosophy claims that unlike a physical object, a living organism is capable of reacting in diverse ways to one and the same informational change which in fact is a change of state. The higher an organism level of nervous system development, the greater the variety of choices it can conduct. For example, a spontaneous furious wind on a mountains top may push a stone to roll down and this effect depends on the wind's strength, the stone's weight, and the slope's angle, while in addition, an animal might try to protect itself by hiding or escaping. Man would think about other more clever possible options as well.

So, whether speaking of observing, reasoning, or acting within the surrounding environment, in approaching it man always uses a purely individual or personal viewpoint and immediately applies the same purely individual or personal justification for what he perceives. In

[6] Peter Adriaans, *Philosophy of Information (Handbook of the Philosophy of Science (Amsterdam,* Elsevier B.V., 2008) p. 48.

all cases the justification includes awareness of various entities' arrangement in a space/time perspective in an immediately evaluated reference to him. With no exception, the evaluation result falls within a conclusion framework which defines the entities' state in a single from a pair of possible contrasting positions: left-right, front-back, big-small, static-moving, dangerous or not, etc. Thus, all of us use binary opposites in order to maintain a picture and figure out its meaning, no matter if considering physical entities or abstract issues such as good and evil.

A basic peculiarity of our species' binary approach to the universe is that all of us find it very difficult to define a meaning unless we bear in mind the possible opposite to what we are facing. In case we cannot do that, the confusion becomes so great that it involves a tremendous intellectual effort which sometimes takes centuries of analysis with no final conclusion. For instance, one can study the thousands of years discussion on what happiness is, due to the fact that the reasonable explanation of being happy cannot be recognized as exactly the opposite of the notion about unhappiness. It is the same with harmony and disharmony etc.

In other words: at any moment we constantly negate what things are not in order to fix what they are indeed. Many thinkers claim that this specific way of the human intellectual "being" is predefined by, and relevant to, our male/female nature. Others suggest that in fact reality is something much different than the representations which man produces by the binary approach.

However, my aim is to discuss the problem only in reference to the most contemporary data and informational issues because in this trend everything sounds clear, consistent, non-mystical, and convincing:

- When a physical thing interacts with another one, a change in "state" occurs.
- Each change of state is data.
- Information is awareness about data.
- There is no information without representation.
- There is no disembodied information.
- Each distinguishable state is a "bit" of information. The binary symbols "1" and "0" have two states and can be used to encode either a positive answer or its negation to any element

in a process of evaluation and/or justification. Therefore, "1" encodes "Yes" and "0" encodes "No" in reply to a specific question.

- The mathematical binary system is useful because it is probably the simplest encoding of information and any entity can represent a binary "1".
- The number of distinguishable states that a system can possess is the amount of information that it can encode.
- The binary system results are easy to save in specific figures using mathematical means and moreover, they can be easily transferred from one place to another by signals, generated in electrical circuits where each pulse serves as “1” and/or its absence serves as “0”. That is what currently happens in any of the IT set of equipment.

I am not claiming that this is the same as what happens in the human brain, but I do not exclude it entirely. For instance biological sciences have already proved that, light falling into ones’ eye generates bio-electrical impulses which pass via nerves to the brain. The same type of bio-electric flow is generated by our sensors for sound, touch, smell and taste. Therefore, the brain has the capacity to “read” these impulses as bits thus turning data into information which produces awareness of the surrounding environment. Perhaps, the bits’ further processing is fundamental for human mental activity in general, as far as obvious from the computer writing and spreading texts as files within various networks, it is possible to interpret words and language into mathematical symbols and vice-versa, based on a bits’ calculation technique. Both scientists and philosophers agree that human rational thinking is always conducted through language, thus logically there is no practical problem for it to be derived from such a process. Moreover, contemporary IT software solutions demonstrate that bits can be processed in a particular way to produce sounds and pictures even in a moving audio visual session and therefore, this might be the specific way man perceives everything that surrounds him.

Although in analyzing these common issues between one’s mental activity and IT I am sure that man is different when compared to the contemporary computer in the following ways:

- The method by which information is saved and recalled as well as in the manner of organizing and dealing with the constant combination of incoming and stored bits from one's genetically saved, socially acquired, and past experience.
- All of us operate the unique capacity of humans to generate associative links among various types of information. Some thinkers call it "producing patterns" which in many cases are individually different thus making people so diverse and this is a real basic difference in comparison to any IT equipment, which uses uniform paths to deal with data.

From this perspective, I believe that philosophy itself is focused on conceptual investigations that are supposed to be far from a logical-mathematical origin and I remember Hume[7] claiming that if a matter concerns abstract reasoning on number and quality, derived from experimental work, this falls out of any philosophic framework. On the other hand, I also know that the binary system inventor is Leibniz and some centuries ago he put it into direct reference to his Monadology[8], which I've already mentioned as the most reliable historic root for recent philosophic-informational analysis. For Leibniz, the monads are the elementary building units of the universe, and can only be found through pure logic. He aimed to prove that all knowledge is composed of these logical atoms or building blocks, and this issue has inspired a long list of researchers.

Leibniz introduces the monads in the following way:

> "The body belonging to a monad (which is the entelechy or sold of that body) together with an entelechy constitutes what may be called a living being and together with the soul constitutes what amy be called an animal. Now the body of a living being or an animal is always organised; for, since every monad is a mirror of the universe in its way, and since the universe is regulated in perfect order, there must also be an order in the representing being, that is, in the perceptions of the soul,and consequently in the body in accordance with which the universe is represented therein."[9]

Leibniz is famous in having created the mathematical Binary System although in his article "Explication de l'Arithmtique Binaire" he shares the view that its origin is Chinese. Having introduced his assumptions on the Monads to his analysis of the human Binary Approach, Leibniz

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[7] David Hume, *A Treatise of Human Nature,* (Internet, Free E-book Project, 2010), available at http://www.gutenberg.org/ebooks/4705

[8] Leibniz, *The Monadology, 77.*

[9] Leibniz, *The Monadology,* 63.

had a significant influence on the development of the future computer as a discipline of symbolic logic. He believed that the laws of thought or human reasoning, i.e. logic, could be described in a mathematical system and language, rather than the normal spoken and written language which he found too ambiguous in its description for that purpose.

In this trend, reasoning is properly concerned with uncovering the relationships between the simple concepts. If we focus on all the possible arrangements of the 'simples' we find things we know already and further understand their essences better. Obviously, Leibniz recognized the complex ideas evolving as a result from various combinations of simple ones which become constructions because of the associative links among them. Some experts on Leibniz even argue that he has suggested arithmetical multiplication being basic for logical operations, such as addition, negation and multiplication.

Nowadays this view is already confirmed at least in writing down and saving human ideas, as far as any text editing computer program is doing just what Leibniz stated – it enables thoughts' transfer into specific figures applying purely mathematical means. Currently, this is clear for everybody. However, in 1984 (a historic moment when few people realized what the IT is) Jay David Bolter already recognized that the computer is a defining technology, a paradigm for understanding and redefining culture, including our views of human nature. He was really successful in making the following forecast: "By promising (or threatening) to replace man, the computer is giving us a new definition of man, as an 'information processor,' and of nature as 'information to be processed."[10] In the same period (1978) Aaron Sloman also analyzed the "Computer Revolution in Philosophy."[11] In order to evaluate the real prognostic power that both authors dealt with, one should bear in mind that personal computers were very slow at that time, their capacity was limited to text edition and accountancy spreadsheets only; there was no office or other networking yet.

But, some twenty years later, it was already much easier for Terrell Ward Bynum to claim about Philosophy of Information:

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[10] Jay David Bolter, *Turing's Man. Western Culture in the Computer Age* (Chapel Hill, The University of North Carolina Press, 1984).

[11] Aaron Sloman, *The Computer Revolution in Philosophy* (Amsterdam and New York, Atlantic Highlands: Humanities Press, 1978).

> "From time to time, major movements occur in philosophy. These movements begin with a few simple, but very fertile, ideas - ideas that provide philosophers with a new prism through which to view philosophical issues. Gradually, philosophical methods and problems are refined and understood in terms of these new notions. As novel and interesting philosophical results are obtained, the movement grows into an intellectual wave that travels throughout the discipline. A new philosophical paradigm emerges. Computing provides philosophy with such a set of simple, but incredibly fertile notions: new and evolving subject matters, methods, and models for philosophical inquiry. Computing brings new opportunities and challenges to traditional philosophical activities."[12]

Further, he concludes:

> "…computing is changing the way philosophers understand foundational concepts in philosophy, such as mind, consciousness, experience, reasoning, knowledge, truth, ethics and creativity. This trend in philosophical inquiry that incorporates computing in terms of a subject matter, a method, or a model has been gaining momentum steadily." [13]

So, the impact of Leibniz' binary system on the general development of mankind in scientific, philosophical and any other discourse is really considerable. In a broader framework than the Philosophy of Information suggests, I agree with Inman Harvey who states:

> "The concept of symbolic reference or representation lies at the heart of analytic philosophy and of computer science. The underlying assumption of many is that a real world exists independently of any given observer and that symbols are entities that can stand for objects in this real world in some abstract and absolute sense. In practice, the role of the observer in the act of representing something is ignored." [14]

His basic concern is:

> "Since symbols and representation stand only in the linguistic domain, another attribute they possess is that of arbitrariness from the perspective of an observer external to the communicators.
>
> In the more general case, and particularly in the field of connectionism and cognitive science, when talking of representation it is imperative to make clear who the users of the representation are and it should be possible to at a minimum suggest how the convention underlying the representation arose. In particular it should be noted that where one and the same entity can represent different things

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[12] Terrell Ward Bynum, and James H. Moor, *The Digital Phoenix: How Computers Are Changing Philosophy*, (New York – Oxford,Special issue of Metaphilosophy, Blackwell, 1998).

[13] Bynum, and Moor, *The Digital Phoenix: How Computers Are Changing Philosophy, 46.*

[14] Harvey Inman, *Robotics, Philosophy of Mind using a Screwdrive* (Brighton, UK,School of Cognitive and Computing Sciences University of Sussex, 2012) available in PDF at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.147.47&rep=rep1&type=pdf

to different observer's conceptual confusion can easily arise. Obviously, computers deal in a different uniform manner."

This particular viewpoint has provoked me to raise a question, which I consider of greatest importance to the Digital World analysis: although representing either "1" or "0" only, are the bits uniform? And I would like to go much further than Harvey does. In his perspective, on the one hand, information is always related to the awareness of an observer, therefore the individual uniqueness of man inevitably makes a "stamp" on everything he/she perceives and understands. Thus subjectivity lays a trace on the bits' capture and processing. This conclusion seems to be clear for Leibniz too:

> "Indeed every monad must be different from every other. For there are never in nature two beings, which are precisely alike, and in which it is not possible to find some difference which is internal, or based on some intrinsic quality.."[15]

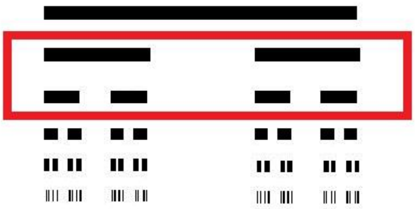
Many other philosophers agree with the issue of human uniqueness being basic for any analysis on the phenomenon - mankind. Perhaps the clearest statement to illustrate this viewpoint belongs to Alison Jaggar[16] who stresses that any view of human nature must take into consideration the influence of an individual's age, sex, socio-economic class, sexual orientation, race, and ethnicity.

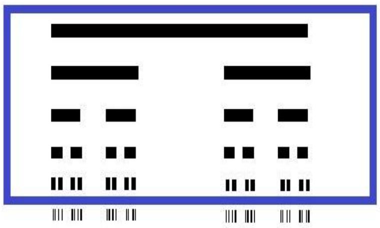
On the other hand, in my opinion the problem is not concentrated in a comparison of man to man mental capacity and activity. I dare to claim that besides subjectivity there is also an objective physical factor that makes bits different from each other because they refer not just to information but to data as well. My logic is simple: nature suggests neither absolute identity nor 100% equality. Just the opposite, uniqueness is a characteristic of any entity; meanwhile the notion of entities' self similarity is a purely human product of evaluation and justification based and dependent on the level of preciseness one applies. For instance, if you measure a line of bricks using an apparatus capable of giving a result in microns, you will find out that all of them vary in dimension. However, if you just intend to construct a wall, a threshold of variation of up to three

[15] Leibniz, *The Monadology*, 63.
[16] Alison Jaggar, *Feminist Politics and Human Nature* (New Jersey: Rowman and Allanheld, 1983).

millimeters keeps all the bricks within a standard that lets you recognize them as uniform and you may build with an assured successful result.

In other words, the ideas of sameness, alikeness or equality are in a direct relation with a constant and inevitable introduction of criteria which lets us just take out of consideration or simply exclude the entities' uniqueness. However, this act does not eliminate them. It is just a technique which man applies to introduce uniformity. In order to illustrate this process I will returns to Cantor's set picture:





Obviously, any conclusion on entities' uniform means a process of ignorance of some of their peculiarities and this is a step which one always provides in conducting generalizations. In reference to Hume's view mentioned above, I will not argue here if a philosopher is supposed or not permitted to measure mathematically the level of the entities' specific characteristics ignorance, but as far as Karl Popper's philosophic methods and conclusions are respected by most of the experts in the field, I see that he considers the introduction of some mathematics being helpful:

> "The logical probability of a statement is complementary to its falsifiability: it increases with decreasing degree of falsifiability. The logical probability 1 corresponds to the degree 0 of falsifiability and vice versa."[17]

So, in a trend which faces all aspects of variability in nature, which logically brings the concept of self-similarity rather than that of uniformity, there is a logical question that I hope computer science will answer: should the bits be treated as an exception? In case, yes – why? If not – how is Informational Theory supposed to change and what is the new outcome?

[17] Karl R. Popper, *Objective Knowledge*, (New York, Oxford University Press, 1972) and John Eccles, *The Self and Its Brain* (New York: Springer-Verlag, 1977), p. 540.

The issue of all entities' individual uniqueness, combined with self-similarity is the core of Benoit Mandelbrot's Fractal Theory which he derived from Fractal Geometry is his great basic discovery. As he puts it:

> "The story of Chaos begins in number, specifically in the mathematics and geometry of the fourth dimension. This is the home of Complex numbers and Fractal Geometry. Unlike the other dimensions - the first, second and third dimensions composed of the line, plane and solid - the fourth is the real world in which we live. It is the space time continuum of Man and Nature where there is constant change based on feedback. It is an open system where everything is related to everything else.'' [18]

Mandelbrot is famous for having said also:

> "This is how God created a system that gave us free will. It's the most brilliant maneuver in the universe, to create something in which everything is free! How could you do that?! …exploring this set I certainly never had the feeling of invention. I had never the feeling that my imagination was rich enough to invent all the extraordinary things. I was discovering them; they were there although no one had ever seen them before. It's marvelous! A very simple formula describes all of these very complicated things. Who could have dreamed that such an incredibly simple equation could have generated images of literally infinite complexity? We've all read stories of maps that revealed the location of some hidden treasure. In this case the map is the treasure!."[19]

According to Mandelbrot, the idea of "recursive self similarity" was originally developed by Leibniz and was further popularized in Jonathan Swift's writing, specifically in reference to similarities within different scales and dimensions. Avoiding the deep mathematical analysis, the core of Mandelbrot's theory claims:

- Every entity in the universe is unique, but it always occurs in numerous self similar forms. Each of these entities is a Fractal (the name was chosen, based on the Latin "fractum" which means a small piece from a broken down bigger entity).
- There is a code which drives (thus predefines) both: the level of uniqueness and self-similarity and this code moves the universe constantly to a greater complexity.
- It is possible to discover and study the code.

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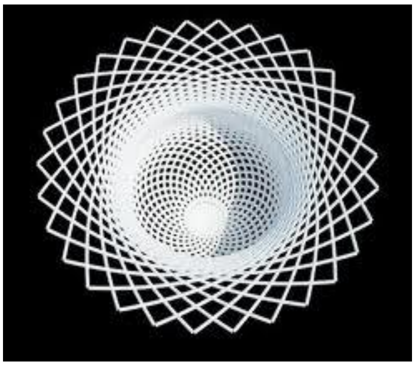
[18] Benoit Mandelbrot, *The Fractal Geometry of Nature* (San Francisco: W.H. Freeman, 1983).
[19] Benoit Mandelbrot, interviewed in "Fractals: the Colors of Infinity" (Arthur Clarke Documentary), available at: http://www.youtube.com/watch?v=pJA8mayMKvY

- The various self-similar forms – the Fractals can be and are repeated both: within one and the same and/or various levels of dimension within the universe.

The most popular example to illustrate Mandelbrot's views on how a mathematical code has the capacity to drive and affect everything including life forms is a comparison between a particular mathematical scheme derived from formulas and the sunflower:



It is also clearly visible that all of the seeds are fractals, producing a fractal structure.

Mandelbrot suggests that one can easily observe the fractals as a phenomenon of combined individual uniqueness and self-similarity: there are no absolutely common drops within a cloud in a rainfall, or common snowflakes in a snowfall. Self-similar fractal life structures can be observed for instance in the cells in a tissue, the branches of a tree and the leaves, the structure of animal and human blood vessel systems, the lungs, and even within brain branching. The fractal structure has already been determined to be a frequently encountered element in fine art and music created long before Mandelbrot's conclusions. There are also many examples of fractal structure repetition at different levels of dimension which science has observed. For example, there are many common forms within crystal lattices and astronomical groups. Recently astronomers report having observed a "DNA" double helix analogue near the center of the Milky Way and still there is no reasonable explanation of the origin of this phenomenon.

It is also important to know that nowadays, physical and biologic signals are also considered as fractal forms and contemporary psychology treats human thoughts as fractals too. For instance, the comparison among the various human brain signals on a multi-fractal basis within a certain period of time is letting medical experts analyze additional information about mental activity when dreaming or conducting a cognitive process[20].

It is a great challenge to summarize Fractal Theory and its philosophic impact briefly. However, as Musgrave[21] puts it, the revolutionary idea raised is that chance itself is governed algorithmically in such a way that infinite variety is not precluded, but rather enabled! "The centuries-old philosophical presupposition that chance and governance are opposite has been effectively demolished by Mandelbrot's amazing discovery." Besides, a very interesting element is that this invention was initially within the realm of pure mathematics, involving neither experimental work, nor empirical observation by sensors. So, this particular case and its great impact on the human notions in general also produced a considerable impact by enriching the conceptions of the philosophy of science.

Returning to the informational aspect of the problem, according to me, the main issue is focused on the fact that mathematical research on fractals and their structures (a study needing massive calculation and very fast computers) can bring humanity to a new level of awareness. A considerable proof for my claim is the new scientific branch of bio-mathematics, which appeared in the 1990s more or less immediately after Mandelbrot's discovery, and it has already developed successful diagnostic methods. For example, this is the early detection of cancer at a stage when the patient has no complaints. The logic is simple and clear: studying general variation rates within one's lungs fractal structure and finding a zone with a considerable rate diversion serves as a proof of the start of some degenerative process.

Another very important aspect of the Fractal Theory application is its being basic for any. type of computer animation. One can observe a lot of demos (for example - at youtube.com) involving various expertise on how to begin with just a set of just a red, a green and a blue triangles, then repeat them in a 3D "recursive self similarity", conducting each time their diverse distortions of shape and size. The final outcome might be a portrait, a landscape or whatever you

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[20] Peter Doynov, *Space-Time Multi-fractal Analysis of Electric Encephalograms (Original Tiyle in Bulgarian:„Пространствено-времеви мултифрактален анализ на ЕЕГ"),* (Sofia, Institute of Mechanics to the Bulgarian Academy of Sciences, Dissertation, 2014).

[21] Forest Kenton Musgrave, *Methods for Realistic Landscape Imaging* (Ann Arbor, MI Yale University, 1994) available i.n PDF at: http://www.labri.fr/perso/fleury/courses/PdP/MondesVirtuels/terrain_generation/dissertation.pdf

wish. Depending on the talent involved, the artistic value of the product may compete the best examples of the fine arts. However, the role of the computer animation should not be philosophically justified as a particular method and/or means of drawing static or motion picture only. We have to bear in mind that it can produce an imaging of individual-mental, some social and some physical processes, all having been invisible till the moment this digital technique was invented. It visualizes as well any computer modeling, thus enabling mankind to generate, analyze and justify concepts derived from the digital simulation of various hypotheses.

In a larger scale perspective, our new capacity of obtaining hidden information either by visualizing the invisible, or by mathematical comparing structures and proportions at a level of figuring out definite patterns and codes, will certainly enrich our notions on the nature of the Universe and the human race within it. Most probably we are already much closer to understanding the meanings and the embodiment of the Julia's, Cantor's, Fibonacci's and other number sets, the Golden Ratio, as well as the essence(s) of the constants in the Universe, such as pi, the speed of light in vacuum, the gravitational constant etc. few fixed values, which make our World possible. It is important to mention here that computer modeling has already revealed: life would be impossible unless these constants did not exist at all, as well as in case they were available, but with a different value. This fact has already been concluded by science in reference to any life form, not just to the human species.

In order to illustrate the enormous philosophic potentiality of Mandelbrot's approach in reference to developing our contemporary notions on the essence of the Digital World, therefore - on our concept on the Universe as a whole, using arguments which anyone dealing with just elementary computing skills could understand, I bring the following very simple example:

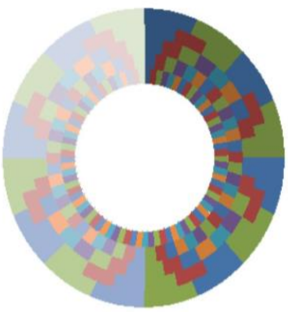

Image -1, Doughnut.

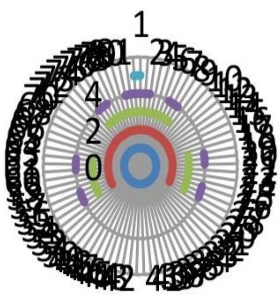

Image -2, Radar.

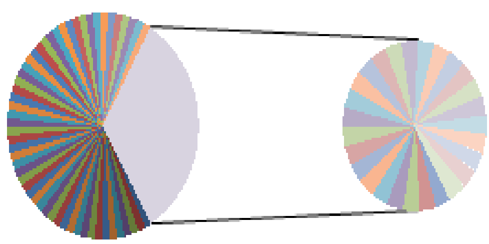

Image – 3, Pie.

Observing the pictures above raises the logical question – what is this? In fact, these are three versions of a Chart which was produced using the popular MS Office – Excel program chart template based on a very simple code (3^5-3^{-1}) as a starting point. Here is the same image in two other versions as well as the Cantor's set (same code) graphics which I've already applied to illustrate some examples.

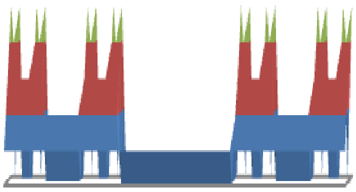

Image - 4, Area.

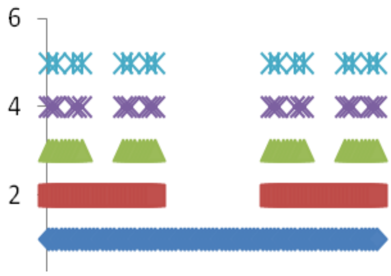

Image - 5, Radar.

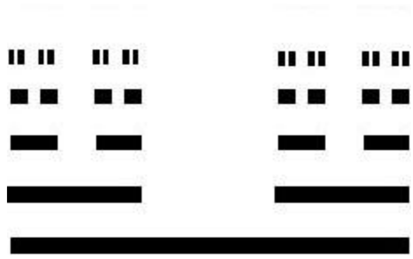

Image – 6, Graphics.

The conclusion is obvious. Any of these images can be produced by a code and, if operating with appropriate software, one can easily save and store them as a line of mathematical symbols and then, whenever needed, reproduce them as images. Therefore, as far as all of the life forms possess DNA in their cells nuclei, which they modify in a time perspective, it is very probable that all of them have a capacity to memorize a process including a stage of perceived data filtering/sorting, some essences' extraction and a final specific storage encoding. Obviously, the simpler organisms provide it very slowly and at a very low scale, meanwhile the more developed a biological form is, the faster and wider data range it manages to process.

Although it may sound strange and unexpected, I dare to make a parallel of Mandelbrot's concept of code embodiment within any fractal structure with Michael-Angelo's statement that there is a sculpture hidden within any stone; you just need to know what to cut off in order to extract it. The current scientific mission should be to extract the universe's fractal codes and then, philosophy will be supposed to develop our new notion. Perhaps this process will take some time, but in fact, it is on the way and the faster computers, the nearer we are to facing this result. We only need to keep our eyes open not to miss it.

So, as Glymour[22] claims, the informational issues have considerably influenced his views and philosophy. One can see the effect not just on the philosophy of science, but also on the philosophy of biology, and the philosophy of mathematics; for instance, as far as man's dealing with data is in direct connection with its symbolic representation, the computation of digits placed a powerful challenge on the philosophy of language as well.

Ontological aspects of the computer programming languages.

Most shortly, language is recognized as the human capacity for acquiring and using complex encoded systems in order to think and communicate. Although many animal species' rational activities (in particular – the communicative skills among dolphins and other mammals) are not studied precisely yet, it is considered that language is a privilege belonging to man only which makes us unique and more important than any other life form. I am very reserved regarding this viewpoint and I find it too egocentric, but perhaps, arguing on it is out of the current framework. However, the philosophy of linguistics is a definite field of philosophy which has involved a lot of inquiries and has also brought our civilization to conclusions of crucial importance. In this perspective, naming the specific techniques and/or methods of programming a computer as language deserves a special philosophic attention.

Obviously, the surface level of the analogy we provide concerns the fact that via languages people share information. So, as far as computation needs an amount of startup data to conduct any kind of processing, including information on what the processing is expected to be, we have to share it with the machines. Thus, the manner and/or the tool we choose to apply are the same which we use in exchanging encoded information among ourselves. Nevertheless it is a contact with a machine (a purely physical system) this is the way we act indeed.

Moreover this first glance consideration, a deeper analysis reveals that if language is recognized also as a system of symbols provoking man to produce representations to deal with further, the internal stages within the contemporary IT software solutions demonstrate a lot of analogy too. For example, engaging memory in principal, and specifically – structuring and

[22] Clark Glymour, *Thinking Things Through: An Introduction to Philosophical Issues and Achievement*, (Cambridge MA, MIT Press, 1997).

operating with different levels of memory, illustrate a much more essential common approach to the informational issues between a human being and a computer. In fact, this "likeness" should not be a surprise to us – in an informational discourse, it is a very logical outcome from a simple and clear observation and justification:

- With no doubt, computers are created by man (both as hardware and software products) to serve information processing.
- Therefore, man has "taught" them what the bits are and how to deal with them.
- Finally, as far as man cannot teach anybody (in the case of computers – anything) to do whatever in a manner that he/she does not know nor think/operate in, logically, man cannot make the IT systems run the bits in a different way than he does it personally.

The result of that activity is interesting: as Reeves and Nass argue, having provided a series of experiments, the outcome report sounds strange:

> "People treat computers with politeness, perceive personalities in their computers, and often interact with their computers much in the same way they would interact with a real person. In popular discourse we have grown accustomed to referring to the manner in which we need to reprogram ourselves, the necessity of debugging our personality, the fact of our hardwiring, or the need to get wired."[23]

Dennis Weiss also claims that:

> "The increasing integration of computers in our lives has led many to argue that the once clear boundaries separating human beings from machines are disappearing."[24]

So, although it appears clear that computer science suggests many significant challenges to traditional philosophical concerns, it is much more difficult to conclude whether it generates some absolutely new philosophical issues. In other words, are the computers and their programming languages so unique that man cannot make a parallel to any other branch of philosophy?

Trying to answer the above question, Adriaans[25] finds it helpful to seek a parallel between the invention of computer languages and the empiricist methodology which made it possible to

[23] Byron Reeves and Clifford Nass, *The Media Equation: How People Treat Computers, Television, and New Media like Real People and Places* (Cambridge MA, Cambridge University Press, 1996).
[24] Dennis Weiss, *Human Nature and the Digital Culture: The Case for Philosophical Anthropology*,(York PA, York College of Pennsylvania, 2008) available also in PDF at http://www.bu.edu/wcp/Papers/Anth/AnthWeis.htm

conceive the development of language as a system of conventional signs in terms of associations between ideas in the human mind. The issue that currently is known as the symbol grounding problem, dedicated to how arbitrary signs acquire their inter-subjective meaning has raised one of the most heavily debated philosophic questions of the 18th century.

Another factor to stimulate and support the computer programming creative process which deserves philosophical attention is that letter frequencies vary by language and this peculiarity had been observed since the introduction of the printed book. Printers note that they always need many more 'e's and 't's than 'x's or 'q's for typesetting English, and other languages demonstrate different frequency patterns. So, the core of the theory of optimal codes was already more or less clear long before Shannon[26] developed its mathematical foundation. Therefore, computer experts had only to think of how to transfer that pattern into an algorithm.

As a result, the product of their intellectual effort raises a series of ontological questions which philosophy has to reply. Generally, they require a comment on:

- Should we assume a possibility of digital objects' existence? In a broader perspective, as far as computers are purely physical systems, are the computer programs physical forms too or not? If not – what are they?
- In terms of philosophy, is there a difference between a computer program and an algorithm? If yes, how to f determine it?
- However, without doubt, computer programs are also symbolic. So, should we develop a notion of their dualistic essence?
- What factors provoke and facilitate the availability and development of a considerable variety of programming languages?

No matter to the approach chosen, an analysis of the above problematic questions has to take in concern some obvious facts. Firstly, any computer program is written in text, which can be edited at any moment. On the other hand, if brought to a machine having the capacity to read it, the program provokes it to start and execute a series of actions. This peculiar property makes it

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[25] Peter Adriaans and Dolf Zantinge, *Data Mining (*New York, Addison - Wesley Publ. Co, 1996(.

[26] Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication* (Urbana, University of Illinois Press, 1949).

quite different to any other text and logically, one may specify this particularity as a relationship between two apparent forms of existence: a textual object causes a kind of physical process conduct. Therefore, in this case we face an abstraction which is embodied within a text that can provoke a concrete flow of electrons within a processor and organize their route in a pre-defined "trajectory." Moreover, this action can be repeated unlimited number of times with a very high rate of preciseness.

In other words, as Turner and Eden put it:

> "Abstraction is one of the conceptual cornerstones of computer science. It is an integral part of program design and construction, and forms a core methodology for the design of programming languages. Indeed, it drives the creation of new programming paradigms. It underlies the invention of notions such as procedural and functional abstraction, polymorphism, data abstraction, objects and classes, design patterns, architectural styles, subtyping, and inheritance. Many branches of software engineering (e.g. software modelling, program comprehension, program visualization, reverse- and re-engineering) are primarily concerned with the investigation of appropriate mechanisms for program abstraction. And much of the progress of software engineering has been achieved due to the introduction of new abstraction mechanisms."[27]

Although philosophers have never agreed on what an abstraction is, the only common element among all views is that they always refer to mental processes in a direct relation with human concepts and notions generation and exchange as well as to their systematization and organization, e.g.: scientific, artistic, moral concepts. Discussing any informational issues which are based on the bits and their digital encoding, logically, all experts build on and try to refer to the philosophy of mathematics. Working in this trend Turner and Eden make an important conclusion – they claim that the distinction between abstraction in mathematics and abstraction in computer science lies in the fact that in mathematics abstraction is information neglect" whereas in computer science, it is information hiding." In other words, they consider that abstractions in mathematics ignore what is judged to be irrelevant (e.g. the color of similar triangles). In contrast, in the process of computer programming, any details that are ignored at one level of abstraction must not be ignored by one of the lower levels. Therefore, these details become involved at some point in

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[27] Raymond Turner and Amnon H. Eden, *The Philosophy of Computer Science* (Amsterdam, Elsevier B.V., Journal of Applied Logic, Volume 6, Issue 4 DOI: 10.1016/j.jal.2008.09.006, December 2008) available at: http://pcs.essex.ac.uk/University of Essex, 2008, available in PDF at: http://pcs.essex.ac.uk/

computer processing unlike the mathematical principle not to take them into consideration at all. Perhaps, this recognition, combined with the possibility to repeat precisely a computer program run as many times as necessary, might be very helpful in making the distinction as to why some thinkers argue that the software is a digital object, different from pure concepts. Nevertheless current brain science claims that concepts as well as any other human mental activity are also based on bit processing.

However, in my perspective, I find it necessary to return to my basic issue: if drawing a general picture, one should not take into consideration the material, energetic, and informational (bit - data) aspect of any problem alone, because they are inseparatable within our universe. Therefore, any form of digital data is directly related to physics – at least as being directly dependent on energy in order to function. This is also true of computer programs and this concerns both: man created programs as well as those embodied within the genes which drive all life forms' development. Therefore, separate analysis of material, energetic, and data components is the real act of abstraction which perhaps is helpful for scientific study in order to achieve a better understanding of some phenomena or processes, but in a generalized discourse, philosophic research should always bring them together, thus preventing fragmentary conclusions.

One can apply the same approach to the difference between a computer program and an algorithm. A printer may deal with more English "e"s and "t"s than "x"s or "q"s, but this is enough to transfer a handwritten text to a machine one. Nevertheless, having just the letters does not let him produce an original concept. Perhaps, this is the basic argument for the contemporary copyright defense system which treats every computer program as intellectual property while algorithms cannot be copyrighted.

However, I would like to suggest that we should be very careful in conducting the program/algorithm distinction analysis in the way mentioned above. My idea is that although nowadays, if facing an algorithm written in digits, it might seem impossible to precisely figure out its embodied meaning, but this may be easy to do in the future. Here I have in mind our changed view of the relationship between algebra and geometry after Benoit Mandelbrot's[28] invention.

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[28] Mandelbrot, *The Fractal Geometry of Nature*, 83.

Many years ago we recognized algebraic formulas as being principal to studies in geometry, but at a certain moment Mandelbrot's talent provided humanity with the knowhow that all geometric forms embody a particular formula or a code as a part of their essence which is possible to extract. He concluded that we are surrounded by various geometric forms which are principal to our algebraic abstractions. Therefore, there is no reason to consider the current inability to recognize the concept of algorithm transfer as irreversible, even though at this moment man does not have the knowledge to do it. In such a trend, albeit severely criticized, philosophic thinking on the computer programs as a cause to event relationship between the input and output is preferable. This approach expects one to think of an algorithm like the steps to solve a problem; you can implement it in figures using a specific actual language. Moreover, this logic explains that to achieve the wanted goal; the following points should be borne in mind:

The computer program is necessary "to tell" a computer **what to do**, while the algorithm is "telling" it **how to do it**.

- In computing, a program is a specific set of ordered operations for a computer to perform.
- Each program contains a one-at-a-time sequence of instructions that the processor obeys and executes.
- In order to compute a result, man may follow a variety of paths: a procedural, a functional, an object-oriented, a specification, or some other one. Thus, the corresponding procedural, functional, object-oriented, specification or other paradigms of the computer programming let the software designers use diverse concepts and methods while looking for a faster processing to more easily and solve efficiently solve a particular task. This fact is also crucial if one has to discuss why a specific result might be achieved successfully by application of different computer programming languages.

The only reservation I have relates to characterizing algorithms as being language free. I disagree with this view, because, the fact that we cannot read a language message within a mathematical code, does not mean that it does not exist. It might remain hidden from us until we learn how to decompress it. Moreover, I would encourage scientists to keep searching and I believe that, for example, there might be very important meaning embodied within some natural constants and proportions such as pi, the Golden Section (Fibonacci numbers), the Julia set, the Cantor set, some genetic codes, etc.

In order to achieve a really general ontological "picture" on the computer language-algorithm relation, I consider one should also bear in mind the following important argument: although the question "what to do" is different from "how to do it", the distinction is easy to see only at a very simple level of analysis; the more complicated an activity is, the more indefinite the demarcation line between both questions becomes. Let me illustrate this:

Case 1 (Simple). The task is to move a person from Sofia to London as fast as possible. The answer to "how to do it" is clear: catch a direct flight. However, even in reaching such a simple goal, the algorithm can choose from at least two options: a ticket purchase for the soonest scheduled plane or hiring an air taxi.

Case 2 (More complicated). The task is just to move the same person from Sofia to London. In this case, the algorithm may suggest a long list of ways to accomplish the task: a direct or transfer flight; travel by train, by car, by ship etc., and there could be no doubt that although fulfilling the same task, a flight from Sofia to London and a walk of the same distance seem quite different regarding the reply to "what to do", rather than just in reference to "how to do it."

Case 3 (the level of complexity grows, keeping the task seem relatively simple). The fact is that I am hungry – the goal is "I need some soup." Now, the algorithm is "free" to perform as follows:

- Make me cook, using whatever I have in my fridge.
- Send me for some supplies with no limit on where and when to do it, and then cook.
- Requiring a home delivery of a soup from a restaurant, or bringing me to some place that I can have it served.
- Completing the mission is also possible by inviting a woman to my place to do the cooking instead of me.

It is easy to conclude that in this case the relation between the issues of "what to do" and "how to do it" is one where the process of choosing and conducting the internal steps to reach a particular result strongly affects it in reference to getting additional outcomes that are not restricted by the wanted goal formula. It is clear as well that the more complex the goal is, the greater is the diversity of the intermediate steps. Therefore, the number and the variety of the additional outcomes undergo a considerable growth, especially in our contemporary era of large scale computer networking and follow up programming's great diversity. Also, it seems impossible to predict all "side effects" which might occur in the process of running a program, so that a software designer could eliminate all of them when formulating the task.

This analysis is encouraging a lot of current IT experts and other thinkers to introduce the term computer platform and recognize it as basic instead of discussing computer languages and algorithms separately. The platforms involve into a set of major pieces of software, as an operating system, an operating environment, and a database, under or within which various applications run. Many computer engineers strongly insist that the computer platform concept should also include the hardware on which the software is installed because its capacity defines and restricts both frameworks: "what to do" and "how to do it" as well as strongly influence the balance between them.

I will discuss the hardware-software issue in the next subchapter, so here, I would like to stress the fact that in reference to informational processing outcomes, recent computer platform researchers do not insist on an ontological view of computer programming languages' key role in comparison to that of the algorithms, as it was some forty years ago. Instead, nowadays authors meet the challenge to discuss the nature of the dynamic data structures, the meaning of their formation and sorting, rather than the essence embodied within the tools to conduct it.

In any event, I would like to focus on the next core question of this subchapter: besides being abstractions, computer programs are also symbolic; should we develop a notion of their dualistic essence? In fact, writing a computer program needs a specific languages' application. No matter which language the designer chooses to use, it is always characterized by a particular syntax and semantics. A basic peculiarity of computer languages grammar is that unlike human languages, they have to be more flexible – they involve variables which drive the information processing activity differently depending on the distinct levels of memory involved in a concrete operation. The grammar in use is very specific for each language to the extent that if not based on one and the same programming language, software products rarely work together successfully unless they undergo some special design to synchronize their performance. Moreover, in some cases, a 100% successful synchronization seems to be impossible even in cases that intermediate interpretative agents are uploaded. Experts in this field claim that this problem is due to the fact that unlike the case of human language, computer language grammar can also serve as a context carrier. Perhaps, judging this statement needs a deep engineering qualification which I lack, so I can just observe the difficulties in this field. However, the semantics related issues are much more clear and easier to discuss. Nobody argues against the fact that all computer languages use some symbols as signs of how to proceed.

In this perspective, as Turner and Eden comment:

> "The grammar of a programming language only determines what is syntactically legitimate; it does not inform us about the intended meaning of its constructs. Thus the grammar of a programming language does not, by itself, determine the thing that people program in. Instead, it is the grammar enriched with a semantic account (formal or informal) that is taken to do so. The semantics is meant to inform the programmer, the compiler writer and the theoretician interested in exploring the properties of the language. Indeed, it is often claimed that to meet the different requirements of the programmer and compiler writer, different semantic accounts, at different levels of abstraction, are required. And the job of the theoretician is to explore their relationship."[29]

Obviously, this trend introduces a dualistic approach to our contemporary notions of computer programming languages. I would like to bring the following argument to illustrate its necessity and make clear why I accept it: if discussing literature, generally the font does not affect content and meaning. Unlike it, again generally, a computer program is strongly dependent on the type of the symbols used to write it in reference to what it produces as a result in a run and even a font change affects the outcome considerably. In other words, as Turner and Eden add regarding program identity in terms of copyright legislation:

> "If we identify a program with its textual manifestation then the identity of a program is sensitive to changes in its appearance (e.g. changing the font). Evidently, it is not the text alone that provides us with any philosophically interesting notion of program identity. Rather, to reach an informed criterion of identity we need to take more account of semantics and implementation."[30]

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[29] Turner and Eden, *The Philosophy of Computer Science*, 88.
[30] Turner and Eden, *The Philosophy of Computer Science*, University of Essex, 90.

Although I understand this peculiarity very well, I disagree with its overestimation and generalization by thinkers like Rorty:

> "By de-physicalising nature and embodying narratives, the physical and the cultural are re-aligned on the line of the virtual. In light of this dialectic, the information society can be seen as the most recent, although certainly not definitive, stage in a wider semantic process that makes the mental world increasingly part of, if not the environment in which more and more people tend to live. It brings history and culture, and hence time, to the fore as the result of human deeds, while pushing nature, as the non-human, and hence physical space, into the background.
> In the course of its evolution, the process of semanticisation gradually leads to a temporal fixation of the constructive conceptualisation of reality into a world view, which then generates a conservative closure, scholasticism."[31]

I characterize digital objects, as specific entities which unlike the traditional physical ones are marked by a limited set of variable yet generic attributes such as editability, interactivity, openness and distributedness. This is the core of the "Theory of Digital Objects"[32] which suggests:

> "To begin with, digital objects are editable. In contrast to conventional artifacts, digital objects are pliable and always possible, at least in principle, to act upon and modify continuously and systematically. Editability assumes many forms. It can be achieved by just rearranging the elements by which a digital object is composed (such as items in a digital list or software library), by deleting existing or adding new elements or even by modifying some of the functions an individual element or a group of elements fulfill. In many other cases, editability is built in the object in the form of regular and continuous updating of items or data fields, as it is the case with digital repositories of various kinds whose utility is closely associated with their steady updating (e.g., databases, transaction or booking systems, currency exchange systems). Indeed, the steady updatability of digital objects suggests that a large group of them have from their very beginning been conceptualized as organized receptacles of change capture. The editable nature of digital objects contrasts sharply not simply with physical artifacts but also with information contained in cultural records or artifacts of non–digital constitution. …
>
> Second, digital objects are **interactive** in the sense of offering alternative pathways along which human agents can activate functions embedded in the object or explore the arrangements of information items underlying it and the services it mediates. While ultimately tied to the pliable nature of digital artifacts, interactivity is here conceived as distinct from editability in that its enactment does not need to result in any change or modification of the digital object. Its key

[31] Richard Rorty, *Consequences of Pragmatism* (Brighton, The Harvester Press, 1982).
[32] Jannis Kallinikos, Aleksi Aaltonen and Attila Marton**,** *A Theory of Digital Objects* (Internet Based Issue**,** Peer Reviewed Journal at the Internet, Volume 15,number 6-7, June 2010) available at: http://firstmonday.org/ojs/index.php/fm/article/view/3033/2564#author

> quality is contingent exploration made possible by the responsive and unbundled nature of the digital object rather than change. In this regard, interactivity enables actions of *contingent nature* (depending upon user choice), a condition that sets digital objects apart from the non–contingent, and arrested responses of physical artifacts and the inert nature of paper and other non–digital records or artifacts. …
>
> Third, digital objects are possible to access and to modify by means of other digital objects, as when picture–editing software is used to bring changes to digital images. ...
>
> Digital objects are thus **open** and reprogrammable in the sense of being accessible and modifiable by a program (a digital object) other than the one governing their own behavior …
>
> The open and reprogrammable character of digital objects is, of course, variable and one important attribute of the contemporary digital landscape has been its steady progression towards a deeper interpenetration of codes, systems and artifacts and growing interconnectedness.
>
> Fourth, as the outcomes of interoperability and openness, digital objects are **distributed** and are thus seldom contained within a single source or institution. In this sense, digital objects are no more than temporary assemblies made up of functions, information items or components spread over information infrastructures and the internet.

I realize that this view can be seriously criticized. However, it sounds to me much more reasonable to recognize working at the Internet as dealing with specific but real things than just with some kind of abstractions. For example, a web search machine is a different entity than a digital photography landscape or an electronic airplane ticket. And all of them are produced, operated by, and function in a particular computer programming language. Therefore, one can always think about a variety of digital objects, as well as observe and justify them. Moreover, the digital objects should not be recognized as computer representations as some IT experts suggest at least until the moment Artificial Intelligence proves itself to be as distinct as human. Meanwhile, a notion of digital objects which provoke human representations as physical objects do sounds to me much more convincing. This applies to computer languages also, as well as to their diversity.

Why are there so many programming languages and what is the ontological aspect of this problem? A lot of analysts refer this question to a relation paradigm language, programming doctrine. However, the core of the problem is that none of the elements in that three component relationship has a precise, globally accepted definition. This fact refers to not just philosophical/theoretical research, but also to the lack of an established unified official international standard in this field. As yet there is no agreement on which paradigm constitutes the best approach to developing software. The result is that one can observe and justify numerous tendencies in computers studies as well as in the field of the programs' design. In order to better understand their nature, one should take into consideration the most recently used one's, bearing in mind that there might be more being developed at this moment:

- Imperative programming – defines computation as statements that change a program's state.
- Procedural programming, structured programming – specifies the steps the program must take to reach the desired state.
- Declarative programming – defines computation logic without defining its control flow.
- Functional programming – treats computation as the evaluation of mathematical functions and avoids state and mutable data.
- Object-oriented programming (OOP) – organizes programs as objects: data structures consisting of data-fields and methods together with their interactions.
- Event-driven programming – the flow of the program is determined by events, such as sensor outputs or user actions (mouse clicks, key presses) or messages from other programs or threads. Automata-based programming – a program, or part, is treated as a model.

Obviously, it is not necessary to be an IT expert in order to figure out that at least to certain extent, the particular circumstances which require the application of digital equipment or informational services, lay a specific start impact on formulating both: "what to do" and "how to do it". Besides, the program to be designed is always in relation with the diversity of the apparatus which execute it. However, I recognize some other factors as basic to developing our notion of computer languages variety and I consider my arguments as being clear and easy to understand, far apart from the not very fruitful philosophizing on what the distinction between a paradigm and a doctrine is.

First of all, computer programming is man-made whereas man is inevitably, characterized by his personal uniqueness which is always most brightly expressed through his intellectual activity and product. The whole human history demonstrates a constant striving and aspiration to individual originality embodied within any kind of human authorship; and there is no doubt that computer programmers are authors, at least, because their outcome is accepted and treated as copyrightable. So, generally, everybody is motivated to do things "in their own way." The introduction of a uniform approach has always met a lot of difficulty. Besides, it is easy to observe, and logical to justify, that the different cultures born and developed by mankind produce a considerable diversity in approaching whatever problem are trying to solve, including computer program design. Perhaps, the following fact is a good illustration: people who speak one and the same human language and even share common educational background, structure different sentences to express the same idea. It is logical to expect the same practice among software engineers.

Moreover, new programming languages often build on existing languages and add, remove or combine features. Sometimes there is a need to make a piece of information encoded in one language readable (interpreted) in another one, so a third language mixes features from both.

Finally, there are a variety of new problems that need to be solved, due to the development of processors, as well as the introduction of multi-core CPUs. The hardware generational change affects computer programming in the following ways:

- Generally, new processors are much faster and thus able to deal with a much greater quantity of information at the same time. This lets engineers involve much more memory in reference to both: "what to do" and "how to do it."
- There is always a necessity to transfer the older language "knowhow" within the new one.
- The introduction of parallel computing made it possible to apply models reflecting different ways that processors can be interconnected. The most common ways are based on shared memory, distributed memory with message passing, or a hybrid of the two.

So, obviously, the ontology of the computer languages remains a great challenge to philosophical thinking in general and any successful concept directly and immediately reflects into the evolution of the IT industry. The same conclusion refers also to the hardware-software correlation.

Philosophical Analysis of the Hardware and Software Correlation.

The computer sciences refer the hardware/software correlation presumably to the memory structuring architecture as well as to some processing unexpected and unwanted events' management. However, my focus in this subchapter will be in a different perspective. I will discuss how man constructs the computer in a manner which I justify as the beginning of an attempt to reproduce some of our intellectual capacity into a physical machine. I cannot decide whether this is a result of a clear mission that humanity has formulated in advance to start designing the contemporary IT systems, or it is a "side effect" outcome of the engineers' creativity, who began to work in the field of computation in the beginning of the 20^{th} century, (I guess) with no clear view on how revolutionary their product will be regarding the human race development. Perhaps, due to the fact of many experts having dealt (and still working) in this sphere for various companies all over the World, firstly, the process had been dedicated to finding out a means of solving particular informational tasks and the idea to create powerful computers which in some of their capacity correspond to man's mental activity, most probably was raised about three decades ago when the technological development encouraged a look at such a horizon. I will spare the whole next Chapter 3 on this point, while now, I will suggest some facts observation and analysis which drive to a conclusion that generating the concept of what a computer is and how it is supposed to operate directly relates to what our notion is on how we think and work indeed. Therefore, we should not be surprised that the final outcome might compete us in many aspects.

First of all, let me make a short overview on what our contemporary notion of hardware and software are. Both are substantial for any computer to run. The following Comparison Chart[33] (which I found at the Internet and I absolutely accept) reveals what the distinction is considered to be and agreeably all of us recently apply:

	Hardware	**Software**
Definition	Devices that are required to store and execute (or run) the software.	Collection of instructions that enables a user to interact with the computer. Software is a program that enables a

[33] http://www.diffen.com/difference/Hardware_vs_Software **01.03.2014**

		computer to perform a specific task, as opposed to the physical components of the system (hardware).
Types	Input, storage, processing, control, and output devices.	System software, Programming software, and Application software.
Examples	Hard disc, Processor, CD-ROM, monitor, printer, video card, scanners, label makers, routers, modems etc.	Quickbooks, Adobe Acrobat, Winoms-Cs, Internet Explorer, Microsoft Word , Microsoft Excel
Function	Hardware serve as the delivery system for software solutions. The hardware of a computer is infrequently changed, in comparison with software and data, which are "soft" in the sense that they are readily created, modified, or erased on the computer.	To set up a computer and/or perform the specific task you need to complete.
Inter dependency	Hardware starts functioning once software is loaded.	To deliver its set of instructions, Software is installed on hardware.
Durability	Hardware wears out over time.	Software does not wear out over time. However, bugs are discovered in software as time passes.

Obviously, hardware is physical whereas software is logical and for productive information processing you need configured and synchronized hardware and installed software. In order to conduct productive information processing, it is always necessary firstly to provide a double phase and double meaning successful process:

- All physical components' configuration (synchronization).
- As well as software upload and installation.

The meaning and purpose of stage one is to integrate the various elements' so that the apparatus functions like an organism whereas each part supports and responds to what the other ones do in order to reach a goal. It is expected that none of the elements would ever act in opposition, contradict, or disturb the pursued goal.

Further, it is important to stress on the following particular features which characterize this process:

- On the one hand, just to have a computer operate, one needs a specific software application to drive the synchronization and integration of the system's components.

- On the other, you may have a computer switched on and running, but it cannot process information unless the appropriate software drivers are installed.

Logically, one can conclude that all particular units within a computer need “awareness” on both:

- The purpose and type of cooperation they are expected to execute as well as the step by step procedure it needed to fulfill the task.
- Of course, in all cases the hardware needs energy to perform the task. However, energy supply alone does not bring the final result and obviously, this peculiarity distinguishes computers from other physical machines which provide predefined specific actions given an energy supply. For example, the rotor of any electrical engine starts rotating and reaches 100% of its capacity once it is connected to an electric circuit.

Moreover, even if all the hardware in a computer is set up to perform as an integrated, synchronized system, there will not be any successful information processing unless an operating system or interpreter is available. If there is no operating system on the computer it would either show a black screen or generate an error. Uploading programs onto the computer to service specific informational requests is possible only after the operating system has been installed. In other words, in order to exist, all computers need a basic set of physical and logical elements in order to become targeted information processing tools and to earn the capacity to deal with further tasks.

Therefore, it seems that in designing an informational processing system, man has copied his personal experience in breeding children; any child needs to be given some data and skills in advance to beginning any activity referring to an informational context (for example: a child has to be aware of what an apple or a pen is before being taught that one apple or pen plus another apple or pen make two apples or pens etc.). This argument provoked the Information philosophers to assume that software is a general term used to describe a collection of procedures, and documentation on facts that perform some task on a computer system. Practical computer systems divide software solutions into three major classes: system software, programming software, and application software.

Software is usually written in high-level programming languages that are easier and more efficient for humans to use (closer to natural language) than machine language. High-level languages are compiled or interpreted into machine language object code.

On the other hand, hardware is best described as a device that is physically available and can be observed as an object then justified as a computer component, unlike software which man has to run on a computer and justify the outcome as being successful before concluding that he had observed it as an element.

Obviously, to a certain extent, a philosopher can directly refer this issue to Descartes theory of "The Mind-Body Problem"[34], bearing in mind that the analogy should not exceed the framework of a two agent symbiosis necessity in order to achieve a common pre-focused or pre-targeted successful activity. Thus, each agent subordinates, supports and enables the mutual operation and definitely cannot conduct any action unless the other one is also involved.

So, although the distinctions are arbitrary and often blurred, software is recognized as being of three major types: operational (systematic), programming (the various programming languages) and application (designed to serve particular tasks, (text editing, accounting, database, drawing, composing music etc.).

The principal activity that makes for effective collaboration between software and hardware within a running computer system is a parallel twin phase one:

- The software orders instructions for step by step changing the state of the computer hardware in a particular sequence.
- In the same time, this ordered and executed change of state of the hardware makes an impact to some of the software memorized components (files), which results in a new informational outcome.

In this process, the software (especially – the operational one, but many application programs too) is responsible for the direct control and management of the hardware and the basic system activity operations, whereas the hardware performance constructs a product in terms of

[34] Rene Descartes, *Meditations on First Philosophy,* (Translated by Michael Moriarity, New York, Oxford University Press, 2008).

change within the software resulting in a diversity of an opened file if compared in advance to and after the processing is over.

There is also another aspect of the “Mind-Body Problem” regarding our views about computers. It is the notion of most users who generally “ignore” the electronic set as an agent, and as John Barlow[35] notes, in the silent world of cyberspace, "all conversation is typed. To enter it, one forsakes both body and place and becomes a thing of words alone." Elizabeth Reid[36] shares also that in the world of computer-mediated conversation, the body becomes an entity of pure meaning; freed of the physical, it completely enters the realm of the symbol, unbounded by physical measures and this is a concern of man’s attitude to both: the physical machine and himself.

Beyond the analogy to the “Mind-Body Problem,” one can observe other examples of similarity between man and computer. First, the physical and the logical components are always housed within a single body. Second, the same corpse body that contains both the awareness of how to run the system (akin to the human nervous system) and also the memorization of all uploaded applications, and preliminary data-bases ,and it stores the processing outcomes.

Perhaps, it can be agreed that the nature of a human’s higher nervous system seems similar as to acquiring skills by the brain, memorizing facts, bearing in mind individual and foreign (others’) experiences. I would stress that what I am claiming here refers to a common process whereas the particular ways and means of conducting these processes differ between man and computers. The main differences concern both: the physical and non-physical agents involved. In comparing hardware to any living organism, the distinction is very visible, and thus it does not deserve any philosophical attention. However, discussing the basic difference between computer software processing and human thinking is a real challenge. Nonetheless, sciences have already agreed that the initial data to be processed in both cases is input either by sensors or by previously stored data.

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[35] John Perry Barlow, *Crime and Puzzlement In High Noon on the Electronic Frontier*, (Edited by Peter Ludlow, Cambridge MA, The MIT Press, 1996) 460.

[36] Elizabeth Reid, *Text-based Virtual Realities: Identity and the Cyborg Body*. *In High Noon on the Electronic Frontier* (Edited by Peter Ludlow, Cambridge MA, The MIT Press, 1996) 328.

In addition to the mind-body approach, discussing the hardware/software correlation in a perspective which allows making a parallel to life forms, and particularly to humans, suggests other arguments. Michael Landmann[37] for instance, refers to the simultaneity of mutual interdependence that exists between biology and culture. Clifford Geertz[38] also argues that cultural and biological developments go hand in hand. "Between the cultural pattern, the body, and the brain, a positive feedback system was created in which each shaped the progress of the other..."

However, whichever analogy between man and computer is discussed, it remains unclear whether the basis of the bits' operation -- characterized by mathematical logic in the case of computers can be directly referred to an animal or human brain as well. At first glance the answer is a definite "no", but making such a conclusion about the future must consider the constantly growing capacity and complexity of contemporary software. Perhaps, the best answer to this question will be the successful or unsuccessful outcome of human brain activity computer modeling. As Rolf Pfeifer and Christian Scheier state:

> "Discussing concepts and approaches such as subsumption architecture, Braitenberg vehicles, evolutionary robotics, artificial life, self-organization, and learning, we have to derive a set of principles and a coherent framework for the study of naturally and artificially intelligent systems, or autonomous agents in a new framework. It is based on a synthetic methodology whose goal is achieving understanding by designing and building."[39]

In addition, the Philosophy of Information (PI) trend agrees with and introduces a specific requirements path to run this process:

> " Like other intellectual enterprises, PI deals with three types of domains:
> - Topics (facts, data, problems, phenomena, observations, etc.); methods (techniques, approaches, etc.);
> - and theories (hypotheses, explanations, etc.).
> - A discipline is premature if it attempts to innovate in more than one of these domains simultaneously, thus detaching itself too abruptly from the normal and continuous thread of evolution of its general field."[40]

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[37] Michael Landmann,. *Philosophical Anthropology* (Translated by David Parent, Philadelphia, Westminster, 1974) 261.
[38] Clifford Geertz, *The Interpretation of Cultures*, (New York, Basic Books, 1973) 48.
[39] Rolf Pfeifer and Christian Scheier, *Understanding Intelligence*, (Cambridge MA, The MIT Press, 2001).
[40] Gunther Stent, *Prematurity and Uniqueness in Scientific Disco*very, (New York, Scientific American, December 1972) 84-93.

Generally, the concept on the human brain function modeling experiment intends to bring evidence whether what man does is done by just applying mathematical means or whether our mental capacity involves something of a non-calculative origin.

I expect that the same experimental outcomes will also bring us more awareness of whether all of us think in a single common way. This is a provocative question because we can observe daily and justify our great diversity in approaching the world. So putting a uniform framework on mankind's mental capacity and activity is always risky and potentially subject to severe criticism. Therefore, I am not brave enough to do that and, I am not convinced that things only happen in that particular mathematical way. However, I recognize that the human brain provides at least the necessary biological housing; the embodiment of people's intellect which cannot produce any outcome unless it works properly. Any brain damaged patient as well as the medical treatments applied for his successful recovery lead to the above conclusion. Therefore, each analysis of how the human race acquires information and further deals with it needs the involvement of a peculiar biological component. So, as far as medical experts identify a lot of very common biological processes taking place within all organisms, no matter their high level of complexity such as the human reproductive system, I consider that one should be very careful in cutting off the option that the nature of mankind is directly related to our capacity for capturing data and its mathematical computation in a common manner.

Besides the way of processing information, the hardware-software correlation demonstrates other aspects of what man has taken from his personal nature and has embodied in the design of contemporary computers. Perhaps in this perspective, it is computer networking capacity is the most significant. Obviously, this is analogous to human social contacts. Throughout the years, computer networks first involved just few machines placed within a relatively narrow space, which were intended to serve particular common tasks that required a higher processing capacity than available in a single machine. This type of networks looked very much like a small community of people who shared labor to fulfill a mission.

The next step in computer network development created the possibility of immediate information sharing and distribution among different informational entries and exits being separated by considerable distances in addition to multi-task and multi-point synchronized activity. Thus a larger social context was implanted within the digital - physical systems and vice versa, human social networking had the means to become a nonstop global communication system. The philosophical impact of the Internet, Facebook, Twitter, et. al. is so great that it needs a separate lengthy observation and study which is beyond my current framework.

The only element that I would like to stress is in reference to man's designing computer networks by importing human practices such as information access limits and firewalls. In the IT sector, both of these terms concern particular techniques aiming to control the information flow among different computers and their users. These are based on a specific structuring of the memory in a way that to access a certain level of bits' configuration, a particular code is required. Meanwhile, a firewall secures a trusted machine that sits between a private network and a public network – a machine configured with a set of rules that determine which network traffic will be allowed to pass and which will be blocked or refused.

In fact, man has constructed computers to keep privacy in the same manner that a human being constantly filters what to share in his spoken communications or demonstrate socially. Although the term "privacy" is used frequently in ordinary language as well as in philosophical, political, and legal discussions, as yet there is no single definition or analysis on its meaning. However, all concepts of privacy in sociological and anthropological discussions regard it as a generally selective human behavior depending on various factors such as the individual's education and culture, the particular goal wanted as well as to the strategy and tactics one has chosen to reach it. Although some thinkers recognize that there is still some confusion over the meaning, value, and scope regarding the concept of privacy, it is absolutely clear and agreed that all of the various information exchange restrictions within a computer network are directly related to keeping one's data secret from some agents. Generally, this means that a computer performs an activity to prevent the opening and reading of some files, but in some cases when men are also involved in communication networking, the data protection refers to preenting free speech as well.

Perhaps, it is important to point out here that in an informational context, common to other technical equipment invented throughout the years, man has also used computers to attack privacy.

As far as privacy can be gained in three independent but interrelated ways: secrecy, anonymity, and solitude. Obviously, networking one's computer creates a basis for possible foreign unwanted interference by others or a direct spying. The peculiarity that I want to emphasize refers to the fact that the monitoring may concern not only people via their computers, cell phones, TV sets etc., but it can be programmed to serve observe or invade a large targeted IT system or network in order to satisfy another IT system. For example, if a research team needs a big database, it may attack other systems' privacy. The core issue in this case is related to whether man has or has not embodied any kind of human moral or ethical values when designing the computer program, It is this choice of ours that defines whether one digital agent will behave as a partner or as an enemy to another one.

So, in reference to my framework, the basic conclusion is that (at least to certain extent) having created computers and their networking in an obvious analogy to his own notions on how he thinks and acts, man has embodied within a physical system a share of his behavior. I It is in a direct relation to all issues of human personal information voluntary or non-voluntary disclosure, and in keeping secret personal spaces and personal choices as to who gets access. Therefore, protection of freedom and autonomy may also concern the same individual informational context for a digital memory and processing agent.

In this perspective, some thinkers claim that the cyber-space is "inhabited" by "digital subjects" which may be just physical ones as computers are, but also human, because once connected to the "web", all of us only represent ourselves as information. However, I disagree with this concept, because it contradicts the universal triple unity of material, energy, and data that (I am convinced) constructs the world. My argument is that any kind of information processing and exchange, no matter if it takes place within a natural physical process (even before mankind was born), within a human brain or within a particular computer or other communication network, is an electronic – material/energetic flow which "carries" data. So, excluding it in discussing "digital subjects" might be helpful as an abstraction for some scientific study, but it does not fit in a generalized philosophic perspective.

Finally, commenting on an informational discourse about the analogy of what man has introduced to the computer systems hardware/software correlation design, I have to point out that it is referred not just to memorizing and processing the bits, but to their initial capture from the surrounding environment and to data processing outcome as well . In other words: man has copied (to a certain extent) not only his mental practice, but also some other parts of his body activity and has transplanted it to the physical machine. For example, environmental data collecting engineers have constructed various sensors, and a variety of hardware peripheral accessories intended to give physical embodiment to information processing outcome. Here, I suggest a short philosophical overview of this issue:

What man does:	What a computer system conducts:
• Data selective detection and collection via human sensors. Selection possible in the framework of the sensor's capacity, but also even within it by psycho-physiological filtering. • Data to information transfer – memorizing and achieving awareness by applying a still unclear technique. Further information processing in relation to predefined or spontaneously occurring intention – resulting in justification and/or decision making, which at least sometimes involve mathematical logic. • Conducting various kinds of free will activity to bring the outcome within a framework of possibilities. • In case the information does not serve any intention, it might be either memorized or ignored. Even if ignored (forgotten) man	• Data collection applying electronic sensors. Selection driven by their detection capacity, which is impossible to suppress out of the sensors constructive and functioning framework. • Data sorting and memorizing in the form of files within the hardware components, according to regulations and procedures, strictly defined by the software. In all cases the further data processing is provided in an absolutely predetermined algorithmic manner executing step by step purely mathematical logic and rules serving concrete goals. • Conducting various kinds of predetermined possible procedures to bring the outcome. • Data is stored or deleted in correspondence to particular regulations. However, contemporary operational systems leave an

can bring back in use some of that information under particular circumstances in future.	option to restore a deleted file. Moreover, any deleted file leaves a specific track/impact abbot its existence.

So, the input-output analysis requires as a first step, a focus on the sensors which bring the data from the environment into the data processing system. In fact, the sensors' key role is expressed in a process of extracting the data component from its external carrier and putting it onto an internal one, which is supposed to transfer it to the local bits processing agent in a coherent way. An etymological viewpoint reveals a common root which puts sensors directly related to both: senses and essences. Therefore, it is recognized that decompressing the data element from its physical embodiment is a substantial phase of reaching meanings, ergo, of things being understood and in such a perspective it is absolutely clear what some say: seeing is believing.

Discussing how man embodied the knowledge of himself into contemporary IT, there are at least two very common features of humans and physically constructed sensors. The first one refers to both detectors functioning: both detect the presence of a stimulus, or they can evaluate the stimulus' quantity or quality. For example, both an eye and an video camera can observe an image within a range of lighting conditions and are capable of not just recognizing if there is light or not, but can also recognize colors.. On the other hand, in accordance with the data extracted, both of them generate bio-electric (for the living creatures) and pure electric signals (for the physical entities). The generated specific electronic flow conducts the captured bits to a processing agent and the signals' diversity contains the necessary background for making a conclusion of what the particular environment is at any point/moment. Thus, the data transfer is executed via the nerves within a higher living organism and via cables within a physical system. One can observe the same process regarding data collection and its transportation in reference to sounds, smells, taste, etc.

However, creating physical sensors, in many cases and in many different aspects, man has granted computer systems more preciseness than he possesses, for instance with temperature sensors. This fact follows man's efforts to invent and construct tools, to assist him in whatever he cannot do personally. The same issue is perfectly valid for the informational outcome embodiment.

In this case man has also provided IT with a large variety of peripheral accessories which let both the information outcome sharing. In this trend, the hardware/software correlation strongly depends on whether the informational outcome has to be shared:

- Man to man via an IT system.
- IT system is supposed to present her calculative result to man.
- The IT system has to drive its own periphery.

Obviously, in cases one and two man has designed the computers to produce and perform informational outcomes in a man readable form: a text, a picture, a scheme, a sound, an audio-visual product etc. Therefore, a display, a printer, a plotter, some loudspeakers etc. are necessary. However, in case three, the mathematically encoded (not understandable by man) numerical result is the only necessary one to drive any type of peripheral from a miniature memory stick up to large scale car production line. Although it might sound strange, the computer to computer encoded approach is also common to what happens in a man's organism. For example, man does not use any word, sound or image display he starts running and his muscles need additional energy compared to ordinary walking. The brain then sends, via the nerves, an encoded command to the lung muscles to contract and relax more often and to the heart to beat faster, so that the blood system brings more food and more oxygen to all cells, who are instructed (by the same encoded means) to speed up metabolism in order to finally achieve the requested energetic supply.

Perhaps, this fast and effective approach of using simple encoded signals in order to reach complex goals inspired Leibniz centuries ago to conclude:

> "God is also a workman able enough to produce a machine still a thousand times more ingenious than is our body, by employing only certain quite simple liquids purposely composed in such a way that ordinary laws of nature alone are required to develop them so as to produce such a marvellous effect."[41]

With no doubt, it is this specific simplicity and efficiency embodied within a human organism which encouraged man to transplant it to the contemporary computers. However, as I've commented earlier, the already studied purely personal human practices and experiences transfer to the hardware/software correlations does not necessarily mean a conscious attempt to reproduce

[41]Leibniz, *Discourse on Metaphysics*, 122.

man's mental capacity in a new physical system. However, this experiment is an ongoing one and it is focused in a different framework than only constructing computers. It is a theoretical research and practical effort focused on designing artificial intelligence, contemporary and future robotics, which deserves special philosophical attention.

To be continued with:

THE DIGITAL CONSTRUCTION: THE THIN BORDER BETWEEN THE REAL AND THE VIRTUAL.

- Constructing the Artificial Intelligence – a conscious attempt of reproducing the human intellectual capacity within machine keeping a Mankind manner and style.
- Modern Robotics – are we recreating ourselves into a new species?

Any criticism is more than welcome by e-mail at: al_laz@hotmail.com

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