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Abstract

The paper approaches the circular relationship of human development in parallel with technologies. The motor, anatomical and cognitive functions were perfected and adapted according to the use of the utensils that were being created, in such a way that life in the city would be practically unfeasible without the use of the various manufactured devices. Over time, this context has made the human brain to acquire specific functions that relate with technology, establishing in this way the paradox of autonomy and dependence between humans and machines. The search for the expansion of physical and mental capacities has transformed man into a hybrid being and has built a virtual city that blends with the physical city. Faced with these reflections, some questions emerge: Would the tools, machines and technologies be mere extensions of the human body or would these devices become protagonists of a system capable of self-organizing, assuming a self-poetic role? Is this the case of the Internet that self-produces without a central command? Are we autonomous beings or dependent on the various existing tools? Can machines be considered intelligent? Can the concept of autopoiesis be applied to machines? Between men and machines happens the phenomenon called coevolution? Could we live without the existence of machines? These questions will be examined in the light of the authors: Charles S. Peirce, Lúcia Santaella, Winfried Nöth, Andy Clark, Edgar Morin, Humberto Maturana and Francisco Varela, among others, who dialogue with the references of artificial intelligence, reasoning, interpretation, control, self-control and autopoiesis.

Keywords : Coevolution, Machine, Extended mind, Intelligence, Reasoning, Autonomy

1 Introduction

The idea of autonomy is opposed to that of dependency. However, for the philosopher Edgar Morin, autonomy is a concept closely related to the dependence of the environment: "In autonomy, therefore, there is a deep energetic, informative and organizational dependence on the outside world [...] that is why, systematically, I do not speak of self-organization, but of self-eco-organization" (1996, p.47). Autonomy would not only be the capacity for free choice, but the ability to be in conformity with the organization of the environment in which the individual is inserted, an autonomous person in the world, capable of perceiving himself in the "complex whole" in which he is a part. When we think of "environment" we must consider the world of the tools, machines and technologies that surround us and consequently how we relate to these devices. We must also remember that technologies weave a parallel city making it hybrid as virtual and presencial often overlap.

We are autonomous as biological beings, but dependent on machines for various activities: to conserve food and to cook them, to wash the house, to our hygiene, to have fun, to inform ourselves, to move, to communicate, machines that save our lives and others that prolong it.

Andy Clark states that we exist only "as thinking things that we are, thanks to a complex dance of brains, bodies and cultural and technological crutches" (2003, p.11).

The search for the human being to expand the physical and mental capacities, the first by means of hand tools and the second by means of machines, made us dependent so that it becomes increasingly difficult to think the city without the intervention of the tools, machines and technologies as instruments that facilitate human life.

People, tools and devices are amalgamated in a sense that stretches out not made a line, where there is possibility of escape, diversion, but as an area, a large range extended to the future, a path that evolve, adapt and change constant and together. However, every technological invention arises as a result of human needs, as Pierre Lévy (2000) explains in the documentary "The Forms of Knowledge". Thus, the dependence of machines is the result of our free choice, since any device is created by another human being always in the sense of meeting a present or future demand.

2 The expansion of physical and cognitive capacities through machines, autonomy or dependence?

The enhancement of devices has allowed man to better understand reality and create artifacts to increasingly expand his ability to relate to the world around him, creating instruments that increase and improve the maintenance of life.

Lúcia Santaella (1997, p.37, our translation) corroborates with the idea that the machines lengthen a human organ, besides distinguishing muscular machines of sensory apparatus or machines:

> *'While muscle machines are ingenious, machines or sensory machines are machines built with the aid of scientific research and theories on the working of the human senses, most especially the eye. They are, therefore, machines endowed with a sensible intelligence, insofar as they embody a certain level of theoretical knowledge about the functioning of the organ that they length'.*

Technological equipment, for the most part, broadens our intellectual possibilities, as is the case with computers and the internet, that is, when we use an electronic device to, for example, write a book and publish it on the internet, we are expanding the arsenal of information that could hardly be stored in our brain, so we increase the amount of information that can be consulted by us and others in a network of connections that goes beyond the barriers of the circle of people known to the author who wrote it, this feature does with which the writer's mind extends far beyond his brain, projected on the computer and enlarged through the internet. Santaella contributes to this conception by stating that "insofar as cybernetic systems are integrating into psychic systems, as artificial neural networks are connecting with biological neural networks, it is an unprecedented cognitive set that forms" (1997, p.41, our translation).

According to Matuck, "to the extent that human thought interconnects with computational tools, we will be gradually integrating a hybrid identity" (2010, p.17, our translation). This new identity turns human being dependent on technologies for their own survival.

Santaella (1997) describes some types of machines and the proper relations with man, contemplating the denomination of the human capacity on which it was based for the conception and, finally, the author ends up extending this capacity establishing three following levels:

(1) Muscular-motor, expands the strength and the motor capacity of the man;

(2)Sensory, enhances some of the human senses, such as vision, touch and hearing;

(2)Brain, increases intellectual ability through greater ability to handle and store information.

Such a line of thought suggests that our muscular, sensory or brain autonomy in a certain way is imbricated with the relation we have with the various devices.

3 Human intelligence extended to the machine

Can a machine be considered intelligent with characteristics similar to a human mind?

To answer this question, an introduction to cybernetics is necessary in order to establish a parallel with the concept of intelligence according to some lines of thought.

The term Cybernetics was created by Norbert Wiener (1961), it carried several sciences such as mathematics, neurophysiology, linguistics, artificial intelligence, psychology, anthropology and others. This line of research allowed the same logical-explanatory mechanism to be applied to living beings, nature, and things. This science became systemic and integrative. As the first results, the principles of control, feedback and equilibrium.

Heinz Von Foerster (2003) reviewed the concepts of cybernetics, making it more complex. The author applied cybernetic principles to living systems and introduced the observer into the observed reality, highlighting the subject / object inseparability.

For Freud, intelligence can be considered "one of the aspects of language or a personality trait" (2013 [1891], p.18). However, he considers that men do not act as autonomous beings because their thoughts and feelings are directed by the ego, id and superego.

For constructivist theory, intelligence is the product of a process of adaptation, in which the mental structures interact and the influence of the external world: the structures of intelligence is the product of a continuous construction of the subject in interaction with the environment. "Structures are not preformed within the subject, but are built to the extent of needs and situations" (Piaget, 1987, p.387).

The Peircean notion of sign consists of the triadic relation: sign-object-interpretant, a relation also called semiosis, which "can be considered as synonymous with intelligence, continuity, growth and life" (Santaella and Nöth, 2004, p.157, our translation).

Reasoning is a term that is associated with the concept of intelligence, since it can be considered as one of the mechanisms most used by the human intellect, because it is a matter of logical discursive and mental operation.

Peirce classified three types of reasoning, being respectively: [1] Deduction, part of the general for the particular; [2] Induction, from a minor premise to a major one; [3] Abduction, affirms a case from a rule and a result.

Thus, we can say that the species of Peircean reasoning are essential functions of the cognitive mind. And, thought at all levels presents a pattern similar to the three types of process.

Santaella enunciates the conception of "Peircean inference as an essential function of the cognitive mind" (2004, p.81, our translation).

Intelligence and reasoning suggests a faculty that can only be attributed to humans. However, the advancement of new technologies shows us that machines already have some of the characteristics that relate to intelligence and reasoning. These concepts seem extremely controversial. But we can say that intelligent behavior is related to the ability to learn to deal with the world, is to develop strategies to find solutions, is the ability to deal with news through reasoning ability.

If intelligence is closely related to the ability to choose, we must take into account that, in order to choose the best and most suitable opportunity, among the various options, it is necessary to evaluate to the maximum all the advantages and disadvantages of the hypotheses, necessitating the capacity of reasoning, thinking and understanding, that is, the basis of what forms the intelligence itself.

So, intelligence becomes a function and no longer a specific faculty of some beings who has brain, so if it is not specifically bounded to the human brain it can also be in machines?

In this context, the term Machine Learning emerges as a field of computer science that has evolved from the study of pattern recognition and computational learning theory in artificial intelligence, also defined by Phil Simon as a "field of study that gives computers the ability of learning without being explicitly programmed" (2015, p.89). The term "learn" goes beyond the barriers of living beings in the cognitive sense of the word, if we think that technological devices have long been able to draw conclusions from previous events, by reacting in a complex way in order to interact with the environment and with the human being without a direct intervention of its creator,

As an example, a device that can draw conclusions from complex situations, we can mention Deep Blue, a supercomputer created by IBM to play chess, capable of analyzing approximately 200 million positions per second, with this potential, it was able to win in 1997, the chess world champion Garry Kasparov, marking the first defeat of a biological brain over an artificial brain.

Deep Blue was built and designed by humans who wrote a program capable of learning and interpreting a series of sequences to surpass another human being. So the question remains who beat Kasparov was Deep Blue or the people who programmed it?

In a first analysis, it seems that Deep Blue cannot be considered intelligent, at least in the sense of an autonomous entity, capable of making its own decisions, capable of judgment. But it can be considered a "borrowed" intelligence if we interpret it as an entity capable of making the best decision in a range of possibilities presented to it with a previously established situation.

A The team of professionals, who programmed Deep Blue, had to predict all the situations of a game of chess. If information was not requested in the programming, the machine would fail.

A machine does not evolve in the same way as a living organism, insofar as it is equipped with the kinds of perceptions necessary to react to a given situation. A living organism develops in parallel with the environment for this reason adapts the changes of this ecosystem without a mechanism that controls it deterministically.

Computers already have the ability to choose the best option within a pre-established context, so they can be considered as having intelligence, sometimes defined as artificial intelligence.

Intelligence is not a specific attribute of the human being, although he has a higher degree and is also responsible for the intelligence we attribute to machines, here we may perhaps suggest the term "extended intelligence," paraphrasing the term of Andy Clark (2011) of "extended mind," considering the mind naturally extended beyond the limit of the body and thus encompassing also the world of machines.

Clark states that the cognitive process is not found exclusively in our heads as various human activities are augmented by the use of technological tools: the pen or pencil as auxiliaries in large multiplications; the use of instruments such as nautical rule, books, diagrams and culture. In all these cases, the individual brain is responsible for some operations while others are delegated to the manipulation of external means.

4 Mental Machine

Just as a mechanical leg can replace a biological leg in the act of walking, a computer can replace a human mind in the act of calculating, from which it has been programmed for such a task. This machine model is deterministic by acting only according to the purpose it was designed. A machine needs to be programmed by a human mind and its action will be to develop specific and pre-established actions. In the face of these reflections would it be possible to attribute the mental faculty to a machine? To answer this question in the affirmative it is necessary to think of an electronic device as an extension of our body in order to save human labor, be it manual or mental.

According to Nöth, "from the point of view of the history of culture, a machine has been defined as an apparatus that, thanks to the injection of force and energy, accomplishes certain tasks and, thereby, saves human and animal labor power" (2001, p.59). The distinction between manual and mental work is not very precise, so all machines save manual and mental work. So we can consider the hypothesis that a computer is a mental machine.

If machines lack the brain, the term "mental machine" seems an antagonistic term, since mental capacity seems to be associated with a brain.

Peirce (v. 4, p.551) did not necessarily associate "thinking" with a biological brain:

> *'Thought is not necessarily linked to a brain. It appears in the work of bees, crystals and in the midst of the purely physical world and no one can doubt that it is actually there as much as the colors, the shapes of objects'.*

Peirce (v. 2, p.56) contributed with the concept that reasoning can be found in machines when it states that "although not all reasoning is computation, it is certainly true that numerical computation is a reasoning".

Peircean theory seems to have been a forerunner of the concept of artificial intelligence, since it dissociates thought as necessarily connected to the biological brain, so thought and intelligence may also be in electronic devices, whose acting is to replace a mental task.

Due to the scientific-technological advances, particularly in the area of computer science, there are scientific currents that affirm that the machine can think and would therefore have an intelligent behavior, a fact that dissociates the mental capacity to the physiological organ denominated brain. As an example, we can cite the work "Artificial Intelligence", from Daniel Crevier (1996).

5 Coevolution: humans being and machines

The term coevolution was first used by Ehrlich and Raven with the purpose of describing the influences that herbivorous plants and insects have on the evolution of each other. From this, it has been used in biology and ecology to represent situations in which two (or more) species affect each other's evolution. An evolutionary change in the morphology of a plant can induce the morphology of a herbivore that eats this plant, which in turn can influence the evolution of the plant, which can affect the herbivore and so on. "Coevolution is the examination of patterns of interaction between two of the largest groups of organisms with close and obvious ecological relationships, such as plants and herbivores" (Ehrlich and Raven, 1964, p.586).

The concept of coevolution has already surpassed the barriers of biology and ecology, assuming a relevant role among human beings, machines and technologies.

If we consider that the human being has its development together with tools that expands the possibilities beyond its corporeal space, so that new abilities are developed as new instruments are created, it is thus possible to admit that the human race develops new cognitive and motor skills with the tools, machines and technologies that have been / are / will be produced throughout history. It is not by chance that Prehistory is divided according to the instruments of labor used by men. The Paleolithic is the period of the chipped stone, the Neolithic is the age of the polished stone, and the Age of metals, the instruments of stones and other objects were gradually replaced by metallic tools, thus improving the motor capacities of those who used it, in a general way we can say that the human body, anatomically, was adapting to the instruments in the same way that the instruments were adapting to the human body. It is obvious that there has been an evolutionary leap with respect to the motor and cognitive abilities of the human being in each prehistoric period mentioned above.

Recalling the importance of stereoscopic vision for the development of the manipulative capacity of instruments. What seems to be more evident is that conditions pointed out today in the development of contemporary human society are not evolutionary

novelties for the species, since adaptive conditions were already given. John Napier (1983, p.119, our translation) corroborates with this theory:

> *If we want to get closer to the origins of the primate and - specifically - the human use of instruments, we should recall the former possession of, first, stereoscopic vision and presensibility, which provides the basis for hand-eye coordination, so essential to the development of manipulative techniques; and second, the long history of verticality of the trunk, which was a characteristic of locomotion and posture of the primates of this Ecocene, millions of years before the advent of bipedalism. These gifts provide the basis for pre-adaptation, as they are called, for bipedalism and the fabrication of instruments. So, it was not merely inevitable; the manufacture of instruments, when developed after a long incubation period, was the culmination of an ancient primate tendency involving the hands, eye, and brain in a triple coordination.*

Napier suggests, through anatomical evolutionary considerations, evidence that the human hand is a brain-environment interface and that instruments over time have brought about certain changes from the point of view of the anatomy of the human body in connection with the brain.

We can say that this historical situation was closely related to the accumulation of work experiences developed by our ancestors. The experiences between man and tools were responsible for developing the motor and mental capacities that we now enjoy applying in the various daily tasks that we execute.

> *Assimilating the use of a tool means, therefore, for man to assimilate the motor operations in charge of this tool. This process is at the same time the process of forming new and higher attitudes - what he calls psychomotor functions - that "humanize" their motor field (Leontiev, 1978, p.7, our translation)*

Technologies have developed as an adaptive medium necessary for the survival and growth of the human population, as the human race has evolved as tools have been improving, so it is possible to attribute the concept of coevolution applied to man and machine. Santaella (1997, p.40-41, our translation) contributes to this line of reasoning by affirming:

> *Increasingly, communication with the machine, initially abstract and meaningless to the user, has been replaced by intuitive metaphoric and sensorimotor interaction processes in computing, imbricated, and integrated systems of sensibility and human cognition. Finally, the computer itself, in its evolutionary process, has gradually been humanized, losing its machine features, gaining new technical layers for the fluid and complementary interfaces with the senses and the human brain to the point where we can speak today in a process of co-evolution between man and computer agencies, capable of creating a new type of collectivity no longer strictly human, but hybrid, post-human, whose borders are constantly being redefined.*

This new 'sensory-cognitive ecosystem' is laying new foundations for rethinking the aspects between man and machines, also the (un)limits of the brain / actuating mind and updating of collaborative processes and the interaction between human and technology. Technological overlays have modified the city's landscape, human relations, and information storage capacity. The complexity of the current world is responsible for the emergence technologies, at the same time, that is the result of them. This fact reminds us of a circular concept of development between men and machines in the historical course, and so it will be as long as science advances.

6 Technology autopoiesis

Autopoiesis can be understood as the formation of an autonomous system, which is sustained through the concatenation of its own operations. According to Maturana and Varela (1995), a living being is an autopoietic system, characterized as a closed network of molecular productions (processes) in which the produced molecules generate with their interactions the same network of molecules that produced them. The conservation of autopoiesis and the adaptation of a living being to its environment are systemic conditions for life. Therefore, a living system as an autonomous system is constantly self-producing, self-regulating, and always maintaining interactions with the environment, where it only triggers in the living being certain changes in its own structure, not by an external agent.

The definition of autopoiesis is related to living things. Is it possible to attribute this term to the means of information technology and communication, such as the Internet?

Nöth (2001, p.67, our translation) answers this question by saying that the distinction between allopoietic and autopoietic systems is not so clear:

> *Autopoiesis in living systems means that the system is not only capable of self-reference and autonomy in relation to the environment, but also of self-maintenance and finally of self-reproduction. Machines are not self-poietic, but allopoietic systems, since they are produced and maintained by men. However, the distinction between allopoietic and autopoietic systems, and more generally between engineering and biology, is not as clear as it seems. [...] Artificial life begins to be created on computer screens, while exploring the possibility of producing robots capable of self-maintenance and even self-production.*

McLuhan suggested that communication technologies were mere extensions of man. However, even though he treats the technical means of communication as extensions of the sensory apparatus of the human being he emphasizes that these means can gain "autonomy", and it must be remembered that from the 1960s to the present day the technologies have advanced exponentially.

With the advent of electrical technology, man has prolonged, or projected out of himself, a living model of the central nervous system itself. To this extent, it was a development that suggested desperate and suicidal self-amputation, as if the central nervous system could no longer rely on the body's organs for the function of shock-absorbers protecting against stones and arrows from the adverse mechanism (McLuhan, 1969, p. 61, our translation).

With the automatic processing of texts by the various electronic devices, a long path has been developed, emerging an artificial communicative intelligence that makes use of networks with a kind of life of its own that self-produces without central control, this phenomenon deserves to be analyzed from the point of view of autopoiesis as an autonomous system that is constantly self-producing and always maintaining interactions with the environment that produces it.

The internet assumes a direct participant role in the processes of human communication, both in the sense of being part of the hybrid man-machine system and in the sense of being an autonomous, self-organized part that faces the human being, horizontally, as a "communication partner".

According to Humberto Mariotti, the internet is an obvious example of self-organization: "as everyone knows, the web self-regulates and works perfectly, without the need for a central command" (2007, p. 146, our translation).

7 Considerations

Machines, tools and technologies can be considered as extensions of the human body, not only in the physical sense, but also in an intellectual conception, insofar as they provide various subsidies for the expansion of our physical, motor and cognitive capacities. The constant development of new technologies has made the human being hybrid, even without the use of instruments directly coupled to the body. We are connected to a virtual reality, whether through social networks, access to an email or even when we check our bank account, they are identities that surpass the corporeal barrier, projecting our personality into a world beyond the physical.

Man transforms the living city through technology, and then needs to adapt to the reality he has made. Then there is a circular relationship in which a technology is invented and the inhabitants of the city need to develop new brain, motor and cognitive connections for the use of these technologies and so on. If before, in a city like São Paulo, we paid the bus tickets with money, today we pay with the “single ticket” that can be uploaded via the web.

The term autopoiesis can be applied to new technologies, not in the sense restricted to the original word created in a biology context (Maturana and Varela, 1995), but rather as a living (but artificial) system that part of a communication that goes beyond any border and adapts to the environment that is inserted. According to Morin, "the internet can be considered as the outline of a semi-artificial neurocerebral network of a world-society" (2005, p.167, our translation). Semi-artificial because it is made up of machines and connections, but there are also humans (hence neuro-cerebral) who are behind it. Computers and people interact in such a way to reproduce one's environment in various ways, people and machines as cells that self-regulate for the functioning of the complex information exchange and access system around the world.

The paradox of autonomy and dependence between men and machines is a circular and constant relationship as machines depend on men to be created and men rely on machines for the maintenance and development of their respective lives.

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