

ONTOLOGICAL FOUNDATION OF THE VIRTUAL WORLD FROM THE PHILOSOPHY OF NICOLAÏ HARTMANN

Fundamentación ontológica del mundo virtual a partir de la filosofía de Nicolai Hartmann

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Abstract

The following article presents a philosophical investigation into the ontological shaping of the virtual world. It is a theoretical contribution to the contemporary debate in the philosophy of computation on the ontological characterization of digital computing and its emerging products, as it proposes an approach to this field of study from the philosophical perspective of Nicolai Hartmann. The main objective of this article is to explain the stratification of the virtual world based on Hartmann's ontological theory of strata and categories. To achieve this goal, a critical review of the state of the art of the philosophical ontology of virtuality was carried out. Then we proceeded to present a stratification and categorization proposal called 'The virtual world factory' which is a hermeneutic ontology of digital virtuality based on Hartmann's postulates. The main conclusions reached are: i) The emergence of virtual world reality is constituted of the same strata that make up the sphere of real-world knowledge: material, organic, psychic and social. ii) Virtual reality is a product of computation that occurs in the sphere of knowledge in which there is intervention of the ideal sphere and the sphere of the real world.

Keywords

Philosophy, hermeneutics, ontology, Nicolai Hartmann, virtual reality, digital technology.

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Resumen

En el siguiente artículo se presenta una investigación filosófica acerca de la conformación ontológica del mundo virtual. Esta es un aporte teórico al debate contemporáneo de la filosofía de la computación sobre la caracterización ontológica de la computación digital y sus productos emergentes, ya que se propone una aproximación a este campo de estudio desde la perspectiva filosófica de Nicolai Hartmann. El objetivo principal del presente artículo es explicar la estratificación del mundo virtual a partir de la teoría ontológica de estratos y categorías de Hartmann. Para cumplir con este objetivo se procedió a una revisión crítica del estado de la cuestión de la ontología filosófica de la virtualidad. Luego se procedió a presentar una propuesta de estratificación y categorización denominada 'La fábrica del mundo virtual' que es una ontología hermenéutica de la virtualidad digital basada en los postulados de Hartmann. Las principales conclusiones alcanzadas son: i) La emergencia de la realidad del mundo virtual se encuentra constituida de los mismos estratos que conforman la esfera del conocimiento del mundo real: material, orgánico, psíquico y social. ii) La realidad virtual es un producto de la computación que ocurre en la esfera del conocimiento en el que existe intervención de la esfera ideal y de la esfera del mundo real.

Palabras clave

Filosofía, ontología, hermenéutica, Nicolai Hartmann, realidad virtual, tecnología digital.

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Introduction

The philosophical inquiry presented below is intended to answer some ontological questions about the new horizon of human life that has emerged from digital computing technologies. These are questions like what is a digital object? or what is the virtual world? The initial hypothesis or idea is that the creation of the artificial reality of the virtual world is a projection of the human spirit and, therefore is made up of the same strata that make up knowledge of the real world: material, organic, psychic and social.

The method used to develop this analysis is hermeneutical ontology, which allows to characterize the strata and categories that constitute what is called the 'factory of the virtual world'. The choice of this philosophical perspective is based on the assumption that there is an intervention in digital virtuality of the ideal and the real world, as in the ontological model of the real-world factory formulated by Hartmann, from whose structures it is possible to grasp the principles, substrate and relationships of the virtual world.

The first part of this paper presents a brief characterization of the current debate on the philosophical ontology of computing and a justification of the contribution sought to this debate following Hartmann's ontological theory. Then, the second part presents the logical-mathematical principles that are the foundations of digital computing. The third part presents the development of hermeneutical ontology that allows the formulation of the stratification and categorization of the virtual world. Fi-

nally, conclusion presents some fundamental aspects of the findings made with this inquiry and the exploration that remains open for future research.

The philosophy of Nicolai Hartmann as the basis for an ontology of the virtual world

The ontological proposal presented is a philosophical research of the virtual world and digital computing developed on the basis of the proposals made by Nicolai Hartmann (1986) in the ontological, epistemological-categorical and axiological fields. According to this philosopher, a constitution characterization of the real world is developed with a theory that addresses the real world based on the strata that constitute what there is, the categories selected to know what there is, the values of each person and the omissions about the interpretation of the world.

The theoretical framework under which Hartmann's contributions are collected is known, as Hartmann and Peterson (2012) point out, as a kind of critical ontology that seeks to get rid of the influence of traditional ontological metaphysics, a trend present in the current approach to ontology, as proposed by Gabriel (2018). A necessary condition to avoid baseless speculation, and thus to be able to focus on what is possible to recognize from the sphere of knowledge about the real world and the ideal world (The logical principles that function as standards for the construction of the world), as indicated by Cuéllar (2012) and Dziadkowiec (2011).

This perspective is embedded in the debate of contemporary philosophy on ways to address the surrounding reality. In particular, that of the contemporary digital telecommunicated society, as characterized by Cubitt (1998), who points out that even traditional ethics have been disrupted in digital virtuality, based on the idea of sharing the world with the other: "In the virtual world, the other has ceased to be a real, material presence, to transform into a distant utopia that we only see in a screen" (Cubitt, 1998, p. ix).

Regarding Aguilar (2011), the implications of virtualizing the reality of a world perceived through the mediation of technologies such as artificial intelligence, cybernetics, big data, among other technologies, force philosophy to think about the existence of man as an agent of action in the artificial environment he has created. This task must be approached from multiple fields such as ethics, aesthetics, hermeneutics, logic, epistemology, among others.



However, one problem in many of the reflections made from philosophy on the virtual world is the fact that it is self-referential. As is the case with authors such as Lev Manovich (2018 and 2020), Sadin (2017), Huhtamo and Parikka (2011) or even more sociological perspectives such as Bauman (1999). All these authors, and many others, develop important reflections on virtuality and its implications in human life, but most of the time they focus their analysis on one, or some, of the aspects that are more relevant to them, ignoring the underlying structures that allow the existence of a virtual reality mediated by technology.

Any philosophical analysis of the virtual world requires a solid foundation distant from the specific phenomenon it addresses, to avoid focusing the analysis on a specific categorical domain of this phenomenon, which is the result of the fractality inherent in the complexity of this new reality. To achieve the right foundation, the philosophical thought directed toward the products and practices of virtuality must come from the foundations of the new digital world, to avoid the self-referential problem typical of the analyses and inquiries carried out nowadays.

In this sense, De Landa (1997) points to the need to advance to an ontological characterization of the world built from digital technologies. The author proposes a method that could be characterized as historical ontological, centered on morphogenesis as a category of analysis taken from the thought of Deleuze and Guattari.

De Landa (1998) identifies three overlapping layers on which the present reality is structured: the geophysical conformation of the matter that constitutes the world; the emergence of the life of species and the consequent genetic processes; and, on these previous layers, the development of the universe of symbolic exchange formed from language, the world and culture.

Digital technological culture emerges in this last layer, which allows coexistence in societies. De Landa (1998) considers that, in terms of digital virtuality, every digital product is determined to a greater or lesser extent by an approach that can have hierarchical order or reticular type. Both fall into two more abstract categories, formulated by Deleuze and Guattari, which would be heterogeneous strata and aggregates.

For De Landa (1998), the strata correspond to a homogeneous nature characterized by control mechanisms, while the heterogeneous aggregates are characterized by the multiplicity and fractality of their components, defined by the way they are grouped. These categories are the basis of a proposal for ontological theory of digital computing products. In this context of the contemporary philosophical debate, it is possible to



perceive the echo of the ontological strata theory and categories of Hartmann (1986), who organizes his research on the basis of the stratification of the world, which he called factory of the real world. Dziadkowiec (2011) structured this stratification proposal from the division of four possible strata: material, organic, psychic and social-cultural. There is a categorical correspondence in these four ontological strata with the three spheres of being, the real, the ideal and the knowledge, as Hartman points out in accordance with Cicovacki (2014).

The purpose of this article is to open ways to a hermeneutical ontology, whose purpose is to explain the stratification of the emerging reality of digital computing, known as virtual reality or virtual world, explained from the sphere of knowledge, but based on the substrate of logical laws and special categories in the sphere of the ideal being. A virtual reality built from the strata that make up the sphere of the real being that allows the emergence of virtuality, in its fourth and most superficial stratum.

To this end, Hartmann's critical ontology is very appropriate for its systematization centered on the material of the real world, away from metaphysical considerations. This ontological model, based on the strata and categories theory, can be a solid basis for advancing on a virtual ontology with useful results. In particular, if a foundation is sought to consider this new universe of interactions with the distant, as referred by Cubitt (1998), and of which, ontological considerations made from Hartmann may provide new lights for the philosophical or epistemological approach (Cicovacki, 2001).

The project to carry out ontological research based on Hartmann's philosophical precepts, according to Poli and Seibt (2010), is shared by a group of researchers from various fields of science and technology. They have used philosophical ontology as a research method in various fields of study such as linguistics, biology, ethics, computing, among other branches of science and technology, or esthetics, as is the case of Claramonte (2016) and his *modal esthetic*, since the ontological foundation, especially Hartmann's theory, serves as a reference and gives them a coherent sense.

Although not evident, philosophical ontology and ontology as computer technology respond to the same type of questioning. As shown by studies such as Poli and Obrst (2010), Poli, Healy, and Kameas (2010) and Guizzardi and Wagner (2010), today we work on unified models of ontological approximation that seek the convergence of the categorical analysis of philosophical ontology and computational ontology technology methods in different fields of computing and cognitive technologies.

The initial premise of hermeneutical ontology is that the strata of the virtual world are an objective of human consciousness, therefore, they correspond to the strata of the real world, specifically those of the real being. This correspondence can be briefly characterized as:

1. The stratum of the physical-sensitive identified as 'hardware'.
2. The stratum that fulfills the organic 'vital' function of programs that give dynamism to the behavior of the physical machine, known as 'software'.
3. The stratum that fulfills the sensitive function of perception, which corresponds to the flow and processing of information: input, computation and output, which implies the human-machine interaction, dominated by the relationships of this data exchange known as 'interface'.
4. The stratum of the social-cultural, in which there is the 'interconnection' between lots of individuals who create an infinite network relationships and possibilities for action through a variety of devices. Hartmann states that: "correction happens where all laws of the logical structure are respected" (Hartmann, 1986, p. 195). In this sense, logical certainty functions as a substrate for the relationships inherent in the virtual world factory in its lowest stratum.

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Logical-mathematical principles as the scaffolding of the virtual world

In the virtual world factory, as in the real-world factory, there is an intervention of the ideal sphere and the logical sphere. Ideal structures are not only a gnoseological aspect of logical understanding. Only from the logical sphere is it possible to grasp the principles, the substrate and the relationships of the virtual world factory.

As Hartmann (1986), the logical sphere is a sphere of data reduced to laws of relationship, of empty forms of content. However, because of the mathematical logic essence of digital computing, the logical sphere is very important for the factory formation of the virtual world.

According to Astorga (2017), mathematicians David Hilbert and Wilhelm Ackermann in their work *Foundations of Mathematical Logic*, raised the so-called decision problem (*Entscheidungsproblem*) in 1928. The decision problem can be described as the question of the existence of

a general algorithm, which allows to decide if a first-order logical calculation formula is a universally true theorem in all its models, i.e., if there is a general algorithm that determines the truth or falsity of any proposition in a formal system.

The search for a response to this problem resulted in a set of mathematical investigations carried out in the 20th century, between the decades of 1930 and 1940, known as the *Theory of Computability*, which theoretically developed the foundations of current computation.

In particular, the contributions of Alain Turing and Alonzo Church, who worked under the influence of the approaches of Gödel's *Incompleteness theorems*, are pivotal. These theorems answered the decision-making problem raised by Hilbert, which was one of the most important fields of research in his program.

Hilbert's program consisted of the claim to base mathematics in logical principles, for which, as Astorga mentioned (2017), he tried to demonstrate that: A) mathematics is followed by a finite system of properly chosen axioms; and b) such an axiomatic system can be consistently tested.

Gödel's work gave a negative response to Hilbert's statements. In accordance with Nagel and Newman (1970), this is because the first theorem of Gödel's incompleteness points out that: any recursive arithmetic theory that is consistent is incomplete. While the second theorem indicates that in any consistent recursive arithmetic theory T , the consistent T formula is not a theorem.

The theories of Church and Turing occurred separately, with diverse solutions that agree in their results. This situation is a demonstration of the principle pointed out by Hartmann (1986), according to which there is full agreement between the laws of the logical sphere and those of the real being.

According to Sieg (2008), Alonzo Church, along with Stephen Kleene, proposed a formal system called *lambda calculus* to demonstrate the existence of undecided problems. This can be considered the simplest universal programming language. It consists of a simple transformation rule (variable substitution) and a simple schema for defining functions. This formal system allows expression of any computable function, like a Turing machine, so both procedures are equivalent.

According to Copeland (2020), Turing theoretically conceived a computer machine whose function is to perform the numerical calculation process mechanically, thus reducing the decision problem to another equivalent, the 'halting problem'. This is to determine whether running a machine with a coded input data ends in a finite number of steps, or if

it falls into an infinite circularity. To this problem, Turing found an answer through the theoretical enunciation of his computer machine. This problem can also be solved applying *lambda calculation*, in both cases undecidability is checked.

The theory of computability is based on these two developments of mathematical logic theory. Church-Turing thesis bases processes from the ontological perspective by which one can begin to assume the way of being typical to the stratification of the virtual world. The way the virtual object is based on a first fundamental stratification that corresponds to the hardware and software layers allow the existence of the intangible conformation of the virtual.

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The layers of the virtual world factory

Hardware: The material layer of virtuality

Turing solution ideally conceives a machine that performs calculations from a series of clearly stated logical instructions. His idea inspired the need to make a technological device that behaves as ‘universal Turing machine’.

A real technological conformation that is able to imitate the behavior of a Turing machine. According to Church-Turing thesis, it means the possibility that a device solves any problem that can be processed by an algorithm.

Likewise, Woolley (1994) explains: “Today we call ‘algorithm’ any mathematical procedure that can be executed by mechanical and automatic means, without the need for any human imagination or creativity” (p. 34), i.e., any effective computation method for any reasonable definition of terms.

The universal architecture solution for a universal computer machine was given by John von Neumann (1993). It consists of a central processing unit (CPU) consisting of three components: an arithmetic logic processing unit (ALU), which performs arithmetic and Boolean logic operations with ‘yes’, ‘no’, ‘and’, ‘or’ operators; and a control unit whose function is to locate, interpret and execute the instructions stored in the main memory. In addition to input/output BUS or device. Storage memory and peripheral devices that allow the input and output interfaces of information are added to these components.

Hardware, as a physical media, results from the idea of configuring circuits to execute programs, calculation procedures of logical-algebraic formulations—algorithms from physical processes artificially created by man, through the manipulation of electrical energy, using various electronic components specially manufactured and assembled for this purpose.

This stratum exists independently the instructions or commands that overlap it, thus complying with the law of autonomy and independence established by Hartmann for the ontological stratification of any entity.

The 'analogue' emerges for categorical analysis. This category is understood as the relationships of behaviors that occur equally in two different objects, one in the dimension of the ideal being and the other in the dimension of the real being. This parallelism allows a real being to imitate a behavior of an ideal entity—determined in accordance with certain logical laws—by allowing the transit of the merely theoretical or conceptual of mathematical logical laws of calculation to its recreation in real physical electronic circuits.

In the physical behavior of the materials used for the development of hardware components, there is a new special category, 'configuration'. Those materials that have the conditions to conform according to behavior parameters that are appropriate dominate a categorical spectrum typical of the physics laws.

In terms of behavior, according to logical-mathematical standards, 'computable' and 'decidability' stand out. In the case of cyberspace, this last category is opposed to infinity. Since, although the scope of this virtual space may seem inapprehensible, as it is within the categorical laws of the computable, it always has finitude. In the case of hardware, fineness is determined by the actual physical capacity of the components that imitate the universal computer machine. The real computing and memory capabilities of a computer are in a temporal dimension, so they are typical of the sphere of the real being.

An example of the lower level of the 'hardware' layer can be seen on the circuit configured as the computer processing unit, which virtualizes the logical operations executed by man under certain parameters or rules of behavior. Another example is virtual memory, a process that seeks to overcome certain physical limitations of the design of 'computers'.

Virtuality is linked to the hardware shaping elements located in the most superficial layer, or limit, that play a role in the process of human-machine interaction. Hardware-specific devices are called peripheral interface. Its primary function is to allow the input and output of machine data.

A key element in the virtual emergence was the development of interface devices—input and output of information—to make them closer to human conditions of perception and communication. According to Lau (1990), the technological evolution of the interface devices allowed dialogue with the machine to be ‘more natural’ or ‘less artificial’, making the machine more likely to man.

The visual interface, known as a monitor or screen — screen or video display — ceased to be a bulky, monochromatic device, in which a grid of light beams was formed to construct images from its activation in a grid made up of small points known as pixels. The current displays are the privileged interface device of the conformations of contemporary hardware.

As Henderson (1999) points out, today’s LCD screens allow the display of high-quality, high-definition images, in a range of 256 000 colors or 64 shades of gray, which is equivalent to the color perception capability of the human eye. This technology seeks to generate that interaction perception with the computer machine

On the other hand, the display device has integrated new layers of hardware sensitive to the human touch, resulting in an experience close to the perception of physical reality. A display on a mobile device incorporates motion sensor technologies, making it more than just an information output interface device. Today the display is a fully interactive device, with simultaneous input and output of information. It is possible to enter information into the computer for processing through touch and motion-sensitive screens, and observe the response of the machine, equivalent to state changes by the machine.

It is also the case with audio-measuring interface devices. There are ear displays that generate sounds from digital codes that imitate the human voice, which are capable of broadcasting messages in the phonetic code of natural languages. There are correlated input devices that allow the human voice to be captured, digitized to be decomposed and translated into a digital code recognizable by the machine.

The most known interface devices are those sensorially privileged: visual, sound and touch. Although, according to Barfield and Danas (1996) and Richard, Tijou and Ferrier (2006), there are also peripheral interface that imitate the sense of smell and taste. There are even motion-sensitive interfaces, which encode and interpret this as data processed and that generate changes in machine behavior. These devices can be combined to generate multisensory experiences that represent the highest virtual degree in the hardware.



As can be seen at this gradation level of the physical stratum of the virtual world factory, special categories are those that have to do with human-machine interactivity. In particular, the 'sensitive' of the virtual world. It allows the connection between human thought and its extensions in the universal computer machine.

To the extent that the human-machine interface devices are closer to conditioning the perception of man, they allow a more intensive and extensive use of digital technologies, characterized by Lieberman, Pater-nò, Klann, and Wulf, (2006) under the 'friendly' category of use.

The human-machine interaction is also determined by 'usability'. This is understood as a special category of this layer which dominates in the case of interface devices, and which groups a set of categories such as: 'interactivity', 'friendliness', 'versatility' and 'availability', which correspond to the gradation of the hardware layer's interface devices. These, in their functionality, respond to the paradigm of being used in multiple ways with different intentions.

In addition to the special category of interconnectivity, it is very important to highlight some categories that make up this group and that are dominant and complementary to this degree. One of these is 'ubiquity'. The level of hardware stratum defined by ubiquity contains the necessary support on which is cyberspace or virtual space dimension. It is because this is the one that allows human interaction and relationships in an area that is not determined by physical space, which enables a ubiquitous presence of the individual. Interconnectivity and ubiquity are categorized as 'mobility'. The creation of the infrastructure that allows the existence of the Internet has been designed to allow the user to permanently and comfortably use the universal computer machine for its personal use. It currently functions as an extension of the body and consciousness.

In the fourth and last strata, this possibility directly affects the emergence of the virtual dimension. However, both are categories of hardware stratum, as the shaping of the telecommunications infrastructure with the devices that allow its functioning is the one that determines its later use on which the upper layers of the factory of the virtual world are built.

The large amount of digital 'data' created, transmitted, stored and permanently modified corresponds to another very special category in the hardware layer; 'digital', which is the creation of digital objects from the encoding in terms of binary code of the information that defines their content.



Another gradation level of this layer of virtuality corresponds to the formation of memory devices that allow the storage of big amounts of digital objects that are created and modified permanently in the world.

The 'cloud', this interconnected and ubiquitous hardware and software conformation, according to Foster, Zhao, Raicu, and Lu (2008), is determined by categories such as 'storage' and 'accessibility' to information. These indicate the ability of this conformation to accumulate information almost infinitely and make it available to users of the computer network. Thus, virtualizing the memory of humanity. Artificial memory has profound implications for the development of culture, as it acts not only on human consciousness, but especially on artificial memory devices.

Hardware represents the physical layer of the physical world, in the case of the virtual world factory. Although it relies on theoretical, logical-mathematical formulations, and laws of the behavior of physical matter.

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Software: The behavior of the virtual machine

The second layer, the software layer, is formed from a substrate that represents the instructions that man indicates to the machine in digital code and the relationships that man establishes from the logical and algebraic indications that are expressed in the formal languages that CPU is capable of decoding and running. Software depends entirely on the hardware; without it the formulation of the computer programs is totally ineffective.

Between these first two strata it is possible to locate a gradation of elements that overlap and allow the upper strata to be based on it. This structure can be outlined as follows: the hardware that functions as the base layer, with the tangible physical dimension of computing. On it overlaps the stratum of the software, which possesses different gradations, that with the hardware form the dimension of the virtual space or cyberspace.

To understand the degree in which the software layer is formed, an ontological version of the England software conformation, Lampson, Manferdelli, Peinado and Willman (2003) is presented, which is the most widely used today.

1. *Firmware*. It is located at the lowest level, at the limit with the hardware. It is considered a 'low-level program' whose function is to establish the logic that controls the circuits of a microprocessor and is considered machine language. Low-level languages, or machine languages, are characterized by a high degree of abstraction and simplicity. The 'programmable' consists of

- indicating changes of physical state to the machine, basic codes representing possible configurations of matter
2. Assembly language. It is on firmware; its function is to symbolically represent the machine binary codes and other elements necessary to determine the processor architecture. The assembly language is a low-level programming language. This gradation allows to point out the emergence of the 'digital', the translation in binary terms, digits, from 1 and 0, of the instructions given to the machine.
 3. Kernel. It has a pivot function between the instructions given in the machine control programs code and the hardware. It is a privileged software (to which the computer user does not have access). Kernel manages and allows orderly access and secure use of the computer's physical (hardware) resources by the various programs that demand it. This is because the hardware resources are limited. Categorically, it is evident that this substrate is governed by 'organization' and 'administration' actions in terms of resource use and 'stratification' of processes, in accordance with their priorities for the needs of the system. This is the dominant categorical set at this level of basic software gradation.
 4. Operating system. It can include the kernel, or be independent to overlay it. This is a degree of software closer to the end user. It consists of several programs whose main functions are: process management, main memory management, secondary storage management, input and output system, file system, protection systems, communications system, system programs and resource manager.
 5. 'End-user applications'. These are the programs that determine how the universal computer machine is; each of these determine the required behavior of the machine. These are the instructions that allow to virtualize countless functions, allowing the computer machine to behave like a calculator, a text transcriber, a videophone, a chess player, the simulation of an ecosystem or an economic, political or social environment. This gradation should not be confused with the next stratum, although it is supported on it, the interface requires interaction with man and data entry by man, and that is not inherent to the software.

In the software layer, applications have been developed that are not intended for the interface between man and machine, but for the interconnection between machines. The standardized protocols that make it possible to handle this communication are composed of code systems, or common languages between computer machines. This allows the integration that makes up the networks of machines that work together known as greeds and computers networks, the top layer of the virtual world factory and the one that makes up the cyberspace.

There are programs in the software layer that indicate the behavior of the machine and the human-machine interface applications. In a higher gradation, there are applications that take care of the interface that interprets the man-machine-network-machine-man interconnection. In this way, the processes for the output of information from the machine and the networks of machines are presented in a friendly way, making them accessible to the end users. This complex communication and interaction are at the upper limit of the software layer. It is the layer of the interface which allows the development of remote computing that overlaps the shaping of the hardware layer in the use of the network structure and information databases accessible through them.

From an ontological point of view, in this layer of the factory of the virtual world, what predominates is the infinite possibility of programming and giving instructions to the virtual machine. Since it can behave like any machine, its way of being will always be an emerging state that will depend on the behavior told to comply with, or, the result of the multiple variable combination that the computer machine incorporates into its programming processes.

In this gradation of the 'software' layer, it is evident that the universal computing machine, or 'universal virtual machine', can behave like any machine by virtualizing any behavior. The stratum of the software is defined by the need to indicate the behavior to the machine, from which it is said that a category of this stratum corresponds to the 'programmable'.

The programmable category is located in the center of the substrate of the 'virtual', since it corresponds to the possibility of generating instructions that, when combined with the possible behaviors for the universal machine, produces an infinite range of possible behaviors, 'virtual'. 'The virtual world' is dominated categorically by programming. For this reason, it is important to determine the way of being of this special category, which lies in the ontological analysis of human-machine communication.



The linguistic dimension in software ontology

The 'machine language' is at the lowest level of software. These are the programs of the imperative language programming paradigm, which translate into a code made up of formal languages, where the procedural instructions of an algebraic logical system oriented to this type of object are found.

The machine interprets any instruction of physical behavior, of electronic circuits, to execute operations sequences that allow to perform correctly any instruction stated in a formal language. This is what makes a universal computing machine, capable of imitating the functions of any machine.

The stratum gradation of the factory of the virtual world is heterogeneous compared to that of the lower stratum. The functional programming languages, and those that were later developed, obey the declarative paradigm, which corresponds to the design of programs in languages that do not take into account the physical architecture (the hardware) of the computer, although it does presuppose its existence. However, this paradigm opposes the imperative paradigm, which is based on the computer architecture. To do this, they work from instructions that regulate the flow of information translated into physical states, indicating the computer how to execute the instructions made by the programmer in a correct syntax in the language designed, as proposed by the Turing machine.

These two paradigms indicate possible ways of being of the elements found in the software, and which are derived from their theoretical assumptions, although both are equivalent, according to the Church-Turing thesis.

Programming is accomplished through a communication process, as it meets the conditions for the emission of a message by a sender (programmer) and the reception by a receiver (universal computer machine); for this process to be completed, as in all communication, a common medium and code are necessary, this is the use of a language, as well as interpretation and decoding of the message.

Programming languages are communication systems between men and machines, the linguistic condition in an ontological sense, understood by Corona (2019) as what categorically determines the second layer of the factory of the virtual world.

Linguistic, as a category of the second stratum, enables the language of a hermeneutics of software, —man-machine language —; the interpretation of the code by which man communicates with the ma-

chine and processes data, generating a response, which is received by man through an interface device.

These systems structured as languages are formed by signs, which according to the classical formulation of the theory of signs, formulated by Charles Morris (1985), are determined by significance. As Ferdinand de Saussure said (1980), or more recently Thaliath (2019), it requires the existence of a code which is the significance and the content described which is the meaning or reference. Due to temporal execution, the signifier is deployed linearly and sequentially.

The language that allows man-machine communication is an artificial language created by man. In this sense, it is due to certain special conditions that define it. It is a formal language, such as logic, which implies a rigorous definition of its terms, its signs, and the correction of the construction rules and their interpretation.

From the linguistic ontological point of view, the gradation law is complied and three categorical levels are structured that overlap and allow the compilation of languages understood by man and interpreted by the machine; according to Astorga (2017) these categorical levels are:

1. The 'morphological', which corresponds to the way in which the lexical units are formed, necessary to construct lexical parser.
2. The 'syntactical', which establishes the structure and the various relationships that are allowed between the lexicons in a sentence, necessary to construct syntactic parsers.
3. The 'semantical' determines the correlation between the sentence structure and its meanings. This is required to interpret the language parser

In this context it can be said that there are the necessary conditions to point out the two special categories that dominate, from the ontological point of view, the linguistic condition of computer programs: computational 'expressiveness' and 'effectiveness'. These involve a hermeneutical point of view. The dialogue with the machine does not support polysemy, the interpretation must be unambiguous and achievable. These categories are necessary conditions that must be met in programs that fulfill the hermeneutical functions of interpreter, translator or compiler.

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The third layer, the interaction: The way of being of the virtual object

The virtual object, made up of that *sui generis* matter that is digital, has characteristics that require its determination for its correct understanding. In principle, it does not correspond to the material layer. It is the product that emerges from the relationships between the substrate into which the information entered, contained and processed by the hardware and software complex is converted, once it emerges as a result of the interaction with man.

Two phenomena that can be noted in the ontological analysis of the virtual world factory result from this activity:

1. The content occupied by cyberspace: digital objects.
2. The network of hardware and software resources that structure interconnected computer networks, known as 'Internet', which, from an ontological point of view, supports cyberspace as the fourth layer of the virtual world factory.

Both phenomena occur as a result of the interaction of the universal computer machine with man, and in turn with other machines. The special category that allows to grasp the result of this communication is 'virtuality', present in all strata of the virtual world. This allows understanding the reality effect of creating digital objects.

The emergence of the phenomenon called virtuality is what connects the hardware, software and human thought, whose domain corresponds to the third layer of the factory of the virtual world, the 'interface', but which rests on the lower strata. The virtual object corresponds to digital object mediated by human action, which produces real effects for those who interact with it.

The existence of the virtual object is determined by the 'interactivity' category, which corresponds to the action that begins and culminates in human reason once there is input and output of information to the universal computer machine, something that occurs in different moments, which is aided and enhanced by the computer's artificial behaviors.

The ontological condition of the virtual objects that make up the virtual world factory is determined by the need to be for someone. The virtual object does not exist without the participation, updating and permanent understanding of the human reason that comes to their representation. This 'being to someone' is a condition of the virtual object,

which defines it from an ontological point of view as a ‘symbolic representation’, with the attributes defined by Gadamer (1991) as category.

If the essence of the virtual object is that of being a symbolic representation, it is possible to understand other categorical attributes from this ontological characterization that determine it. As for its existence, although real, it is always ephemeral; it corresponds to the moment when someone participates in the representation of the virtual object. It is updated in the dialogue with the machine and, consequently, there is a hermeneutical understanding experience that completes its existence in that being for someone. Once the dialogue between the machine and man is over, the digital object disappears and stops existing, at least in its virtual mode. Its existence is limited to the content of instructions encoded in the format of the file containing the digital object.

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Before and after the interaction experience with man through the computer machine interface, the virtual object does not exist, it vanishes into layers and layers of code that is finally translated into binary codes stored in bits, which according to Negro Ponte and Plaking (1995), is the measurement unit of the digital code.

Another category that defines the virtual object is ‘multiplicity’. It is based on the conformation of the matter that is the digital code, constituted as a set of instructions to the computer machine. There is no individuality principle, since every time a file containing a digital object is played, it is exactly identical to the original file, thus disappearing the difference between original and copy. It is executed identically by the universal computer machine that meets the requirements of components and devices needed to do so.

This proves that the virtual world is something *sui generis* in terms of the real dimension, and according to Hartmann (1986), identity and temporal are special categories that define the real. What characterizes identity, as to the unique condition of the virtual object, is its unique possibility as symbolic representation. Each participation in the representation of the virtual object is unique, since in the historical condition of the human consciousness it experiences each moment only once; in terms of its conformation, the digital object is identical and multiple each time it is updated. Human experience gives digital object virtualization the condition of unique experience.

The experience of the virtual object in the upper layers is based on the gradation of the lower strata on which the virtual world factory is supported. In the case of hardware, interface devices allow human interaction with the machine; and in the case of the software, the gradation of applica-

tions allow the interaction, which are the programs that indicate behaviors to the machine, and which are designed to be used by ordinary people.

In both cases, the dominant categories are those that point to the possibility of forming the universal computer machine as a device that operates from a very important special category in the factory of the virtual world, that of the 'interface'. This category allows the computer machine to act as an extension of the human body, due to the possibility of being personalized by each user, making it interactive, friendly, portable and adaptable.

The next step in the virtual world factory is the creation of digital objects that do not virtualize phenomena of the physical dimension, but whose objective is to define information about other digital objects. In this layer, the relationships of the virtual substrate become much more complex, since, from digital objects linked to other digital objects, new digital objects are created whose relationship is to provide exclusive information about the digital conformation of these digital objects. This technology is based on the so-called semantic web or web 3.0.

The fourth layer of the virtual world factory: 'digital communication'

In the beginning, universal computing machines were designed for interacting with man, like many other tools. Hence the importance of the development of the previous stratum, where occurs the interface that allows human-machine communication. However, once an artificial entity is developed that is capable of communicating with artificially defined languages, a new paradigm of machine shaping emerges.

The shaping of the artifact that emerges by incorporating telecommunication technologies into digital computing and computing produces a new entity. It has the ability to virtualize complex behaviors of universal computing machines, as it functions as an auxiliary mechanism of consciousness that incorporates the capacity of human socialization.

The result is a multidimensional compound of virtual relationships, activities, interactions, programs and behaviors that occur in the dimension of cyberspace and is known as the information society. One of the trends that the society of digital technological culture develops is 'The Internet of Things', as presented by Espada, Martínez, Bustelo and Lovelle (2011), as a trend that seeks to develop technologies that interconnect

machines with specific features to virtualize and control their operations remotely and automatically.

Universal computing machines are not physical realities like a car or a vacuum cleaner. They require the stratum of the hardware, but in their higher and more developed strata, like that of distributed task software. It is possible to design the programming of computer behaviors that provides the ability to perceive the environment, and, thus, behaviors of self-determination, adequacy, prediction, and learning in a high autonomy degree to fulfill its functions. All this, according to Klusch (2012) and Demazeau, Dignum, Rodríguez and Bajo (2010) characterize them as 'intelligent agents'.

This is one of the most advanced phases in the development of 'artificial intelligence' (AI). One of the last frontiers of cognitive science and technology, which, according to Russell and Norvig (2016), AI is an artificial machine that performs tasks that maximize its chances of success in executing a function. As can be seen, this is a very advanced degree in programming the behavior of the virtual universal machine.

Human interaction with application interfaces built using the 'AI' parameters incorporate a set of technologies, such as 'geolocation' as noted by Wong, Stoyanov and Sirer (2007) or 'augmented reality' according to Bimber and Raskar (2005), enriching the experience of the reality of the virtual world, thereby building experiences that are only possible in this dimension.

The 'web' is the most user-friendly interface on the Internet. It does not have a plain conformation, it is structured from gradation relations, which begin in the stratum of the software, and rise toward the stratum of the human-machine interface that is concrete in the digital objects, in addition to having a reticular or heterogeneous aggregate architecture, as characterized by Landa (1998). The upper stratum of the factory of the virtual world, that of the 'virtualized consciousness' emerges from the interconnection with the machines.

The next gradation level of the environment or interface of communication and interconnection is known as 2.0 or 'Social Web'. It has an ontological difference with the traditional web focused on multidirectional communication. Social networks consist of platforms that enable the creation of user communities, registered in these environments for communicating and exchanging objects and virtual experiences with other members of the group with whom they share interests.

As for the gradation of the last stratum of the factory of the virtual world, and its categorical determination, there is Web 3.0, also known as



'semantics web', although it has this numbering that refers to a chronological or sequential order, in accordance with Barassi and Treré (2012), it actually co-exists and functions as a support for the emergence of the most complex social web environments.

Conclusions

It is possible to point out that an ontological characterization of the strata that make up the factory of the virtual world, following the ideas indicated by Hartmann, allows to understand the marked emergence process of virtuality.

The stratification of digital objects and the virtual world proposed differ from theories such as the heterogeneous strata and aggregates raised by De Landa, and other theories about virtual products, in its ontological foundation that characterizes the emergence of the virtual world to a stratified process that goes from the material base to digital virtuality. In the case of De Landa, his theory focuses on the elements of programming, software, without considering the emergence of the virtual as a process based on a material reality, which, in a stratified way, allows the appearance of virtuality. The ontological proposal presented here seeks to account of the complete process that allows the transit between matter and the physical processes that occur on it until the formation of the virtual phenomenon. It consists of a sequence of four strata:

- The matter of the configured components, known as the hardware.
- The vitality of an organic behavior, which as a motor provides instructions that change the behavior of the previous stratum, that of the software.
- There is interaction between men and the machines of the communication interface produced by artificial languages, in the strata of sensory perception, consciousness and psyche.
- The product resulted from these interactions between men and the machine represents a new reality for humanity, the virtual world, with practices and traditions that form cyberculture.

The characterization of the four strata of the virtual world factory presented here is a contribution to understanding this emerging phenomenon of the digital technological culture of the 21st century. However, this approach is limited to an ontological research that does not seek



to advance speculation about the ways of being of digital culture and the virtual world.

Ontological research is only intended to account for 'How', i.e., to point out the way in which the shaping of the network occurs. As for 'what', multiple lines and research programs remain open, which can be based on this ontological characterization to investigate from the epistemological, the axiological, the logical and the esthetic perspective, special content that integrates all dimensions of what has been characterized as cyberculture.

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