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OPERATING LANGUAGE VALUE STRUCTURES IN THE INTELLIGENT SYSTEMS

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Abstract. This article shows other relationships, in addition to cause and effect/true-false, to make AI more intuitive. We approach mathematical modeling to the structure of human cognition, showing that both 'translate' the real world. Next, we outline a universal cognition framework to validate mathematical models on a cognitive basis. We compared this structure with its axiomatic-logical characteristics, superimposing it on modeling and set theory. We show that the structures of the linguistic process operate value to establish meaning by correlating logical pattern and contextual pattern. These relationships give rise to different semantic values for data collected outside or within the context. Modeling deals with 'relationship' to generate interpretation. Consistent meanings result from the 'processing' of this 'relationship', which must occur in a unified way, imitating human cognition when operating values through axiomatic (contextual) and logical characteristics in the construction of unique meanings. Human cognition and intelligent systems are matched in the way they operate values to construct meanings, provided that the systems present a model linked to mathematical and non-mathematical relationships. Thus, modeling establishes a bridge between the 'conceptual world' and the 'real world', offering guidance for where to look, directing the construction of meanings and decision-making.

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1 Introduction

Expressing situations in the context of reality and real-life relationships through mathematics involves building models that 'translate' mathematically real-world phenomena. This modeling process will be more enlightening of the situation investigated the closer it gets to the structure of human cognition because it is exactly the human cognitive process that makes the 'translation' of the real world so that it becomes intelligible.The suggestions in this article are intended to teach the machine to work by integrating contextual reality into decision-making, combining value structures in a cohesive way, just like the human mind. This centralization gives the system characteristics of intuitiveness that will avoid cases such as the deep learning model called BERT, from Google, which sometimes makes relationships between words in a decontextualized way, claiming that a bird has twice the probability of having four legs rather than two; or cases like the GPT-3, which gives answers such as that grass blades have eyes or that a horse has four eyes (Edwards, 2021).

This article does not deal with the existing mathematical modeling categories. Instead, it makes considerations about a broad approach based on the universal structure of language / cognition, integrating real entities into the relationships established between them, and elucidating how the essential elements of human cognition (Monte-Serrat & Cattani, 2021a,b) operate and can be categorized.

This categorization (in an ordered pair, in equivalence class, succession etc.) is not taken for granted. On the contrary, it results from a combination of value structures into a cohesive whole that operate in human mind. Clarifications on the natural language core offers ways to formulate or build tools that portray, in intelligent systems, the relationships that exist in this integrative scenario. It is precisely this centralizing scenario that will make mathematics more than formulas, making it a model for solving problems. Thus, it gains rationality, being intuitive as humans.

Cognition process presents axiomatic aspects. They are related to biological activities linked to brain function, in the role of collecting information on the context in which stimuli are generated Monte-Serrat & Cattani (2021a,b). Along with them, there are the logical features, which organize the stimuli collected in a special 'syntax' (Magrani, 2019), classifying them. Both together constitute the dynamic conceptual process of language, which organizes information into categories of 'meaning'. This entire information construction process involves the operation of value structures that we describe in this new frontier research. The axiomatic (biological) and logical aspects of language are approached in a structural perspective of cognition being linked to the functioning of value structures (Monte-Serrat & Cattani, 2021a,b). Therefore, we provide general categories for discussing value operations, analyzing their characteristics that contribute, together with the core of cognition, to the formation of meaning.

1.1 The universal structure of cognition in mathematical modeling validation

The quality of tools that make use of mathematical models also depends on the development of theories like the one we present in this work. Although mathematical modeling involves equations, sub-models, assumptions, restrictions, initial and boundary conditions, among others (Cha et al., 2019; Dym & Ivey, 1980), these criteria are developed on a cognitive basis Monte-Serrat & Cattani (2021a,b) that needs to be well explained.

Mathematical models are characterized by relationships and variables (Simon, 2019; Dym & Ivey, 1980; Cha et al., 2019). While the variables abstract parameters from the context to the system (for example, the model can be dynamic because it depends on changes in time, or static, time-invariant; can be empirical for focusing on empirical findings or inductive for focusing on a logical structure), relationships operate on values. The systems that apply mathematical models adequately relating inputs and outputs, variables and relationships, to the task to be performed (which implies other variables), will maximize the results.

Not only does the use of as much information as possible make the model more accurate, but also the use of information about the structure in which this information is produced is essential Monte-Serrat & Cattani (2021a,b). These are parameters that help to estimate the behavior of the studied system, and to describe the system properly Simon (2019).

To delineate the cognitive structure that involves the construction of values to generate meanings needs a radical simplification (Kuhn, 2012) in search of model precision, making it easier to understand and analyze. Complexity, on the other hand, induces variation in the model, moving it away from the intended purposes. Better precision means understanding how to operate values, giving the systems a certain ability to generalize to adjust these values to other data.

The evaluation if a model accurately describes a system must take account of the structure of cognition that we are exposing in this article, as it is responsible for the construction of meaning, that is, it provides to the system the ability of understanding the task. This evaluation precedes the training done by a neural network or by machine learning, for example, because it deals with the nucleus of cognition, which houses the origins of semantics and statistics in data analysis Monte-Serrat & Cattani (2021a,b). The universal structure of cognition can be a way to test the validity of the general mathematical form of a model.

The models are designed to meet certain situations or data set and, for this reason, they have application limitations, not crashing into other domains (Simon, 2019; Cha et al., 2019; Dym & Ivey, 1980). We intend, with the explanation of the value structures that involve modeling, that the system has increased the understanding of the world in the sense of being adjusted to the empirical information, but also, that it has the capacity to extrapolate to situations or data beyond those described in the model. This, in our opinion, is possible through qualitative and quantitative predictions inspired by the basis of cognition, which is, respectively, axiomatic (collects information from the context where the information was generated) and quantitative (works with previously established comparative parameters that ideally represent the data generation process). We hope that the content of this article adds value to mathematical models by providing insights into the intuition of human cognition that can be applied to these models, giving them the ability to go beyond common conclusions about the phenomenon under analysis.

1.2 Preliminary remarks: Describing the universal structure of cognition

Our concern in this piece of work is in the apparently new field of analysis of the cognition process, which may have the power to change the way we see the world, or to change how we model intelligent systems. A crucial part of the modeling process is the evaluation of the model by checking whether it accurately describes a system (Simon, 2019). This article offers clarifications on how the structure of values behaves in a model and in the universal structure of human cognition.

In this way, the model's adjustments to the empirical data, the parameter adequacy tests to validate the general mathematical form of a model, will be more appropriate as these tools not only adapt the models, but are also able to extrapolate a known model to fit to a general model, giving consistency to the results (Monte-Serrat & Cattani, 2021b).

Many types of modeling involve only causality (logical feature of the language) (Simon, 2019; Cha et al., 2019; Dym & Ivey, 1980), but one must be careful to also consider the axiomatic aspect of the language, since the purpose of modeling is to increase the understanding of the world. The model's validity, then, lies not only in its adjustment to causality observations, but also to empirical ones. The integration of both reflects the core of human cognition, making the system able to provide insights into situations or data beyond those described in the mathematical model.

The description of a mathematical model can contrast with real-world standards when the perception of similarity is reduced to rational rules (Kuhn, 2012; Newton-Smith, 2002; Nickles, 2003). The human cognitive process results from the rationality incorporated to abstract parameters of the context, including, therefore, the axiomatic feature (linked to the context) that overlaps the logical feature (linked to a previously established value). This integration of resources is the key element for cognition to operate values in the construction of meaning under a dynamic process. We consider, then, that if only the logical feature of the language is operating values, it does not reflect the dynamics of the human language. The logical feature establishes values in advance, discarding the possibility of collecting abstract parameters from the context (Monte-Serrat, 2017; Monte-Serrat & Belgacem, 2017; Monte-Serrat et al., 2017).

1.2.1 Axiomatic-logical structure of language

Principles that govern the linguistic process are behind mathematical modeling because we are dealing with structures that overlap themselves: human language process translates reality into their mind; and modeling translates problems into mathematical formulations.

The construction of concepts by the linguistic process to proceed with this 'translation' has to do with the logical-axiomatic structure of language (Monte-Serrat & Cattani, 2021a,b). Language or cognition is a human ability to mentally represent the contextual reality from which information is taken. It is a process with a dynamic aspect (op. cit.) that considers a context in constant change (Monte-Serrat et al., 2021).

The dynamics of cognition is performed through a unique structure Monte-Serrat & Cattani (2021a) that combines two characteristics: the axiomatic characteristic, in charge of collecting the stimuli from the context; and the logical characteristic, which organizes stimuli into categorized information, within a 'syntax' (Magrani, 2019).

The axiomatic-logical relationship is the nucleus of human cognition, functioning as an interaction destined to give consistency to the final product: the fleeting reality starts to correspond to the "before" and "after" characteristic of the logical chain and from this relationship comes the meaning (Monte-Serrat & Cattani, 2021a).

Adopting the concept of human language as a dynamic system Monte-Serrat & Cattani (2021a) recognizes the non-reductive character of the universal, as it does not stop at the logical aspect of language (which anticipates the value of interpretation), but also encompasses space for indeterminacy, bet and risk of the axiomatic (biological) aspect, which makes the language adapt to the context, interfering in the interpretation. When it comes to artificial intelligence, both aspects (axiomatic and logical) must be considered.

1.3 Presenting Sections

This article suggests that, in addition to the cause and effect / true-false relationship, other relationships should be considered so that machine learning makes AI more intuitive. To become our proposal clearer, this article is divided into four Sections. In the Introduction, we bring a basic notion of what mathematical modeling is to bring it closer to the structure of human cognition, showing that both 'translate' the real world so that it becomes intelligible. We present the universal structure of cognition in the validation of mathematical models since the criteria of the latter are developed on a cognitive basis. We make preliminary observations to assist the systems modeling process and present the axiomatic-logical structure of the language with its principles that overlap with the modeling. In Section 2 we discuss the structures of the linguistic process that operate on value, since meaning is the result of correlations between values established with a logical pattern and can also be conditioned to the contextual pattern (biological or axiomatic stimuli). These relations explain different semantic values for data collected outside the context. Section 3 is dedicated to the role that 'relationship' has on modeling structures to generate interpretation. The meanings result from the 'processing' of information, from interactions that occur in a unified way. We present the functioning of cognition and value structures in an operational language, showing that they are the same aspects presented by the integration of body and mind in meaning-building operations. The universal structure of language is described in its axiomatic and logical aspects to serve as a basis for understanding value modeling in the construction of unique meanings. We also describe two trends in set theory to show that the structural operation of value can occur in relation property and in logical relation. Then, as an example, we describe a modeling work, running in the year 2021, of language processors that would meet the axiomatic and logical features of the language, making these processors more intuitive in identifying authorship in texts. We conclude, in Section 4, by equating human cognition and intelligent systems in the way they operate values to construct meanings. We show the importance of the mathematical model to represent the interpretive behavior of devices. Mathematical modeling is linked to the phenomenon of mathematical and non-mathematical relationships. In this way, it mimics the functioning of human cognition that is linked to phenomena of logical and axiomatic relationship respectively.The perception of equivalence in the functioning of both helps to establish a bridge between the "conceptual world" and the "real world", making the latter able to be represented by consistent mathematical models that become a guidance on where to look.

2 Value operator structures in the linguistic process

Operating values in the linguistic process is specially linked to cognition, since the meaning (that is a result of this operation) is an immediate and fundamental data of man's experience with languages (Tamba, 2005, 2014). Identical linguistic (or sign) forms can have different meanings; different forms (signs) can refer to equivalent meanings (Tamba, 2005, 2014). This statement demonstrates that the linguistic process reveals partial autonomy in establishing correlations through its structures. A mathematical model can then limit the meaning to be designed on pre-established patterns (logical pattern) or it can be conditioned to the evaluation of the contextual pattern to construct the meaning. The semantics resulting from the human cognitive process is characterized, then, not only by logic, but also by principles that guide the transformation of the senses linked to biological stimuli (Andler et al., 2002; Tamba, 2005). This explains different semantic values for data collected out of context, conflicting with the values provided by the latter.

Van Buren (1967), commenting on the work of Bréal (1900), about 'Semantics: Studies in the Science of Meaning', states that, while linguists of those days were concerned with the exclusive study of language as a 'system per se', Bréal turned to the importance of intelligence and will in the science of meaning. Bréal (1900), according to Van Buren (1967) tried to systematize this phenomenon through laws.

Although we agree with Bréal that language is not a 'per se' (independent) system, our path in this article is not to establish laws of language, but to explain to the reader what the structure of the linguistic process is to construct meanings. When the mental universals - which underlie the principles outlined by linguists in an attempt to state the facts - come to the surface, it becomes evident that something else, in the linguistic process, participates in the construction of meaning, not just logical cognition.

2.1 Cognition and value in the meaning formation

Cognition, understood as a process Monte-Serrat & Cattani (2021a,b); De Saussure (1989) for acquiring knowledge and understanding, is necessarily linked to the linguistic process. If there is no language, there is no understanding (Araújo, 2004), nor evolution to processes and functions such as: judgment, evaluation and decision making (Denning, 2014; Monte-Serrat et al., 2017).

The deepening of research on these topics leads us to the concept of value, present in both human language and artificial intelligence. The relationship between value and the production of new knowledge through Artificial Intelligence, AI, is something much sought after to make it intuitive.

The term cognitive computing is associated with the mimicry of the functioning of the human brain in the sense of carrying out decision-making (Denning, 2014; Monte-Serrat et al., 2017). The cognitive process analyzed from the perspective of computer science seeks quick solutions to problems difficult to be solved by humans (Goodfellow, 2016) in which the real challenge lies in the intuitive resolution that seems automatic to humans. This intuition must be coded so that the computer can understand the world according to a hierarchy of concepts (Goodfellow, 2016). We believe that the description of how values that interfere in meaning are formed is essential for mathematical modeling.

Monte-Serrat & Cattani (2021a) teach that the structure of language and the structure of artificial intelligence overlap, so that language is conceived as a form and not a substance. Based on this point of view, the notion of value helps to elucidate, in this form, how to build complex concepts from the simplest ones. When thinking about value, one must consider the 'relationships' between the terms. Value depends on 'relationship', which is an essential form of language, whether biological or artificial.

Interpretation involves evaluation, the 'way' how the data are related (valued) to construct the meaning. Valuable activity in the interpretation of data has to do with semantics and statistics , in which the weight of the relationships is decisive to reach consistency, avoiding manipulation or distortion in the estimated result (Monte-Serrat & Cattani, 2021b).

The machine learning task uses training data and cannot be understood as something that leads to the learning of meaning (Bender & Koller, 2020). Mathematical modeling is responsible for inserting a relationship in the intelligent system that will cause values (meanings) to emerge. The value or meaning can ideally be taken for granted when referring to something anticipated (rules that determine what is worth and what is not), but it can also assume a relationship with contextual reality, making this certainty elusive (Monte-Serrat & Cattani, 2021a).

The symbolic system (language, image, numbers, etc.) used by AI is founded on previous assumptions that drive and determine its functioning. However, the meaning (value) is amorphous and can escape the rigidity of its predictability precisely because it operates in a field of dynamic abstraction and difficult to understand, which interferes in the state of the art of the expected result.

The loss of control over the virtues previously advocated by AI reveals a clash between the fragmented reality of practices and the supposed unity of artificial intelligence practices. From what has been explained, it is concluded that value is an element that prevails in the symbolic order (language, signs, figures, etc.) and that there is an urgency to understand what its role is for the future of artificial intelligence.

3 'Relationship' in modeling structures to generate interpretation

For Tamba (2005) meanings result from the 'processing' of information, which, in turn, results from interactions (some known, others unknown). Scientists, according to the author (op. cit.) try to describe how linguistic meaning occurs in a unified way. Although they have not yet reached a consensus, scientists agree that it is the 'processing' of information that takes precedence over computational modeling and artificial intelligence (Tamba, 2005) (page 130). Tamba recalls that there is a need for a symbolic level correlated to the neural activity of the human brain.

Our approach in this article brings together, in just measure, elements of information processing, without forgetting the dynamic functioning of human cognition (neural activity). We outline a structure by which human cognition operates values encompassing biological and logical processes in the construction of meaning. Then, we use this biological model with its relationships to inspire the structure of mathematical models for intelligent systems.

3.1 Cognition and value in an operating language

Monte-Serrat & Cattani (2021a,b) argue that language and cognition are aspects of the same process. For the authors Monte-Serrat & Cattani (2021a,b) - although 'intelligence' is defined as the ability to recognize data and assimilate it or is conceived as a system of classifying notions in terms of the polarity of right or wrong - , 'interpretation' and ' understanding ' only exist if there is language (Araújo, 2004).

Language mediates between reality and the human mind, matching things to ideas: without language there is no way to interpret the world (Monte-Serrat & Cattani, 2021a). The authors also argue that 'skills' should be seen as the result of a cognitive process, making up the final stage of intelligence processing. Monte-Serrat & Cattani (2021a) consider that assessment or decision-making skills are the end-product of the universal structure of intelligence. It is in this sense that language and cognition are strictly attached.

Interpretability as a characteristic of language depends on knowledge of human linguistic functioning. In agreement with Monte-Serrat & Cattani (2021a,b) that human language is a process and not a substance, it consists of a system of identifying patterns even of non-parametric data, generating consistency in the interpretative result. In this way, biological intelligence or intelligent systems are based on the 'way' data is processed, not only on the 'quality' of the data collected. Interpretability results from a process in which there is an indication of value for the item analyzed to build meaning. According to them (Monte-Serrat & Cattani, 2021a), this value comes from previously established rules (idealized rules) (Monte-Serrat & Belgacem, 2017) or comes from reality (experimenting with context in dynamic systems).

3.2 Body and mind integrated in meaning-building operations: axiomatic feature of the universal language structure

The axiomatic (biological) foundations of language are linked to the dynamic process of cognition, which ranges from data collection through subsystems to the arrival of this data in the central cognitive system, which organizes them, giving them meaning (Perlovsky & Kozma, 2007). The axiological aspect of the linguistic process involves (Monte-Serrat & Cattani, 2021a):

i) recursion, preserving the characteristics of the context from which the data were taken;

ii) synchronization, which is an integrative operation between the input of stimuli in the human body and the connection of these stimuli in the logical chain that will give them meaning (Gangopadhyay et al., 2020; Kozma, 2007);

iii) blood flow, which is related to neuronal activity (Song et al., 2006) and the specific functions of brain areas (Gernsbacher & Kaschak, 2003);

iv) interdependent subsystems linked to a central cognitive system; the interaction can take place by coupling (integration) or by segregation (Kelso & Tognoli, 2009);

v) mediation between the real, symbolic and imaginary kingdoms, ensuring the interdependence between contextual reality and the human mind (Damasio, 1994; Wallon, 1934; Lacan, 1949; Padilha, 2000; Monte-Serrat, 2018; Carter, 2019). Body and mind are integrated in meaning-building operations (Monte-Serrat, 2018; Bergson, 1896);

vi) Consciousness presents a neurodynamics ranging from vague and unconscious states to more concrete and conscious states (Perlovsky & Kozma, 2007) (p. 1), giving rise to the investigation of a hierarchy of linguistic structures (Ding et al., 2016) (p. 158);

vii) cognition always seeks the best result through a 'reverberatory generalization' (Werbos, 2007) (p. 122), optimizing the entire system by proposing decision parameters that integrate results;

viii) symbolic system capable of representing phenomena perceived by the individual giving them semantic value (Wallon, 1934; Pitt, 2020; Dretske & Wolf, 1996; Fodor & Fodor, 1987).

3.3 Cause and effect relationships: Predictability and value form the logical feature of language universal structure

The importance of value (P value) as a criterion in scientific research is due to that there is no absolute way to measure the adequacy of thought to reality (Rorty & Maximiliano, 2015) p. 23. This fact justifies the use of specific P values or the adoption of another arbitrary threshold. This is an example of what occurs in human cognition, in which the apprehension of reality occurs through the application of some method or criterion, which in turn raises the need to verify whether that method or criterion provides a correct knowledge of the same reality. Only through the application of a criterion is it possible to know if a certain image or idea is the faithful and correct reflection of reality (Rorty & Maximiliano, 2015) (pp. 24-25).

Intelligent systems work with hypotheses in machine learning, providing an early interpretation of a phenomenon or a possible correlation in a way that eliminates other possibilities for interpreting a phenomenon. This hypothesis organizes cognition in a way that 'illuminates' areas of imprecision. This is how a hypothesis allows for reasoning predictions (deductive or inductive reasoning), predicting the result (meaning) of an experiment or a statistical probability that would happen under specific conditions. The role of logical reasoning is to impose 'the' path to objective knowledge and to provide 'autonomy' (Kenshur, 1995), operating as a general reasoning standard, without reference to a particular meaning or context (National Council of Educational Research and Training, 2017).

Logical reasoning is guided by axioms (truths) that, when proven, become evident truths that can be considered obvious facts (Eccles, 2013). Logical reasoning is based on a 'proposition' that contains a value. A proposition is a true or false sentence (but not both) (Eccles, 2013). There is a difference between general declarations and propositions: general declarations become propositions when a numerical value is assigned to n (Sundstrom, 2014).

The truth value (true or false) of the conditional statement 'If P, then Q' depends on the truth values of P (hypothesis) and Q (conclusion), as there is an implication: the assumption that a statement is true, leads to statement that another statement is also true (there is an anticipation of a meaning/result).

The process of demonstrating a result in logical reasoning has a 'right order'. In this process, the hypothesis has the role of an intermediate conclusion that is obtained until the desired conclusion is reached: if the hypothesis is valid, then the thesis is also valid. This 'correct order' anticipates the value of an interpretation.

4 Structural operation of value in language for the construction of unique meanings

The elements listed in 3.2 and 3.3 do not exhaust the human linguistic process but represent it for the purpose of describing the linguistic structure that operates values in the construction of unique meanings. Our proposal makes it possible to arrive at meaning as the only result of an axiomatic-logical process, thus distancing itself from the succession of meanings attributed to separate elements. The linguistic / cognitive process integrates all the components of Sections 3.2 and 3.3 making a synthesis, and not a sum when constituting the units of meaning. This synthesis involves an intrinsic instability of meaning because it results from a dynamic process, and not from the rigidity of linguistic laws.

In this Section we describe the main challenge of all linguistic semantics: that of apprehending the relationships between forms and meaning in languages (Tamba-Mecz, 1998; Tamba, 2005) (p. 67). These relationships are as evident as they are difficult to explain and their conception changes according to the conditions of use (Tamba-Mecz, 1998; Tamba, 2005) (p. 67).

Tamba (Tamba-Mecz, 1998; Tamba, 2005) (p. 98 and following) considers that there is an organization in the semantic structure to form distinctive units. There is also a readjustment of values in accordance with the context spheres. For this organization to occur, there are general principles for structuring the senses: i) synonymy, to ensure referential equivalence; ii) antonymy, which couples an element to its opposite or negative; iii) hyperonymy, consisting of a subdivision process to form a complex sense.

Synonymy is the principle that guarantees the establishment of equivalent values allowing one term to be replaced by another, ensuring interchangeability without changing the meaning in all contexts of application of the sign. The equivalence in this case may derive from logic, or it may present a relationship of gradual, relative similarity. The similarity of referential (relative) dimension will have the similar value of the signs considered from the same referent, that is, although with a different expression, the signs have the same referent (Tamba-Mecz, 1998; Tamba, 2005) (p. 92). Anyway, there is no categorical difference between the signs and therefore they are interchangeable, causing no change in the value / meaning.

The opposite is up to antonymy. It has defining properties such as: it only links elements of the same category; establishes the minimum level of context for the substitution of one term for another to produce the opposite meaning. Antonymy has a binary ('or'), dichotomized character (which can be contradictory: front / back; polar: long / short; reverse: up / down; reciprocal: buy / sell). Antonymy relations do not refer to fixed units, but vary according to the context (Tamba-Mecz, 1998; Tamba, 2005)(pp. 97-103).

The identification of hierarchical structures in language led scientists to elaborate the concept of hyperonymy to dissociate these structures from conceptual logical classifications (Tamba-Mecz, 1998; Tamba, 2005) (p. 103). Tamba (1991)(pp. 98-99) conceive hyperonymy as the foundation of the category that corresponds to the maximum degree of schematic generalization in the order of perception (contextual / axiomatic in the case of this article). The unity of the category is transmitted to the subcategories by maintaining the main characteristics (same parts, same predicates), devoid of any distinctive properties, thus regulating the level of abstraction or conciseness in which something is categorized (Tamba-Mecz, 1998; Tamba, 2005) (p. 108). This property results from the recursion in the linguistic / cognitive process Monte-Serrat & Cattani (2021a) regulating the degree of value determination in the construction of meaning. This relativity in determining values leaves open the possibility of using competing values to point out meaning, in different categorical degrees. It is essential to remember that this regulation takes place according to the context. If this regulation happens despite the context, ambiguity can occur. The relative neutrality of value in the human linguistic process represented by hyperonymy is explained by the axiomatic aspect (biological, dynamic) of the universal structure of language, which ensures consistency in the construction of meanings / value (Monte-Serrat & Cattani, 2021a,b).

4.1 Two trends in set theory to explain the operation of values

The intervention of concepts such as ordered pair, equivalence class, succession, function, etc., that appear in the mathematical discourse, reduce numbers to sets. Sets began to encompass concepts by organizing them, making mathematics derive from a single source, set theory (Bourbaki, 1970).

Abe (1992) affirms that this axiomatization of set theory aimed at resolving paradoxes and founding mathematics, has acquired an artificial character, as it has failed to consider the contradictions derived from its principles. Axiomatized mathematics is based on Cantor's definition of a set: 'a collection of defined objects and "distinct from our intuition or our thinking", brought together as a whole' (Abe, 1992) (p. 6 our highlight). Other mathematics, which did not 'suffocate' contradictions and, therefore, did not follow Cantor's definition, appeared, presenting characteristics based on physics (Abe, 1992).

There are, therefore, two trends in set theory: a purely mathematical one, treating sets as any mathematical objects; and another that considers sets under an non-mathematical situation and seeks to adapt this situation to purely mathematical sets (Abe, 1992) (p. 8).

What we can infer from this introduction to set theory is that, just as (De Saussure, 1989) neglected semantic aspects of language to focus only on logical aspects, in mathematics, starting from Cantor, there was also an 'epistemological cut' , disregarding the contradictions arising from intuition, leaving the latter with the condition of non-mathematical activities.

In this Section, we intend to show that these two aspects of mathematics reflect the universal structure of language: axiomatic (biological) and logic. Cognition, when operating values, depends on the integration of both, otherwise there will be paradoxes like Russell's (Fodor & Fodor, 1987).

According to human cognition, it is possible to integrate rational activity using non - mathematical concepts, since the construction of meaning occurs in 'relations'. For this, it is necessary to apprehend that the context axioms (biological or related to physics) obey a founding hierarchy, which cannot be confused with the hierarchy resulting from logic. So, this hierarchy can be considered a non-mathematical truth, as it does not operate a logical system.

Abe (1992) (p. 107) states that in all branches of knowledge there are a small number of basic and simple principles, or categories, which must be accepted without discussion (axioms).

4.2 Structural operation of value in relation property and in logical relation

Without dwelling in depth on set theory, which is not the purpose of this article, we make some considerations about aspects of set theory (without exhausting them) that are relevant to the content developed here. Among them is the importance of relationships for mathematics: relationships 'carry' value between one set and another. We understand that relationships establish property values and logical values. Property relations are provided by the context and cannot be ignored in the construction of meaning: if there is a relationship, values arise. Logical relationships are detached from the context, as they follow rational principles.

Abe (1992) (p. 133 and following) highlights three major categories of relationships in the set theory: identity relationship; equivalence relation and order relation. Identity relations can be identical, reflective, unreflective, symmetric, asymmetric, anti-symmetric, transitive and intransitive. Equivalence relationships guarantee exchange of equivalent values in accordance with the equivalence classes. The relations of order, in turn, apply to both mathematics and empirical sciences; they can be partial (according to conditions such as reflexivity, symmetry, transitivity), or pre-ordered by maximum and minimum, for example. These three broad categories, in our view, are due to mathematical truth (identity relationship and equivalence relationship) and non-mathematical truth (relations of order).

Returning to Russell's paradox (Fodor & Fodor, 1987), or Russell's antinomy in the light of these three major categories of relationships, this paradox is classified as a logical relationship (mathematical truth). Thus, it only links elements of the same category, establishing the minimum level of context for the substitution of one term for another.

Human cognition, in its universal structure (Monte-Serrat & Cattani, 2021a) also integrates non-mathematical logic, building values according to the axiomatic aspect (biological, contextual), classified as relations of order. Under this point of view, Russell's paradox disappears within the context of the reality of the barber shop (pre-ordered). If we disregard this non-mathematical relationship, and make an abstraction for logical reasoning, the paradox reappears.

4.3 Application of non-mathematical values in the modeling of language processors

Although this text does not deal with the mathematical modeling categories themselves, only taking a theoretical approach on how to integrate real entities in relationships so that the system is more intuitive, we describe an ongoing experiment with word processors intended for Authorship Attribution in PLN (Gomes, 2021). Much emphasis has been placed on the logical relations of language, which leads to sophisticated systems such as BERT and GPT-3 to misclassification (Edwards, 2021). We are (Monte-Serrat et al., 2021; Center for Artificial Intelligence NLP2, 2019) working on modeling that considers the context (non-mathematical relations, classified as order relation) together with the logical relations of language. This is an innovative work in the attribution of authorship, disseminating information from data obtained in practices of multidisciplinary groups (C4AI) in the processing of the Brazilian Portuguese language. We present techniques to improve the analysis of texts in Portuguese in an inclusive way, considering the syntactic and contextual analysis (discursive analysis) (Monte-Serrat & Cattani, 2021a). The meaning is not taken for granted but depends on an intelligence to interpret it. That is why we are working with suggestions for systems to operate syntactic and semantic interpretation in an interconnected way. We also suggest improvement through techniques that help the system to identify authorship assignments working on two fronts of language: logical and contextual (discursive). Since mathematical modeling deals with the 'relationship' of values that generate interpretation, consistency in the processing of a specific list of values will indicate the construction of singular meanings by a given author. We are planning to work in 2 steps: in step 1, a model will be used to determine the syntactic structure pattern of the Portuguese language based on Corpus BDCamões (Grilo et al., 2020) and on Complex Network techniques applied in Universal Dependenies; in step 2 we intend to investigate the attribution of authorship in a new syntactic analysis under a discursive perspective, looking for correlations in the syntax used by a given author. These correlation options give rise to semantic effects that deviate from the standard syntactic structure of the Portuguese language (step 1), giving it originality and creativity in the production of meanings (concept of authorship). We also plan to verify the syntactic consistency statistically (K-NN), since the statistics interfere in the semantics (Monte-Serrat & Cattani, 2021a).

5 Conclusion

Concluding this research work on how cognition - be it of men or intelligent systems - operates values to build meanings, we remember that the mathematical model has an important role in this process, since it is a mathematical representation of interpretive behavior of devices.

The content of this article helps to make mathematical models with operation similar to human intuition. For this, we describe how the universal structure of language / cognition behaves in the linguistic process and then make a comparison with the structure that guides the mathematical theory of sets.

We show that mathematical modeling is specifically linked to the phenomenon of mathematical and non-mathematical relationships, which makes us equate with the functioning of human cognition, linked to phenomena of logical and axiomatic relationships. This understanding is essential for engineering and science, engineers and scientists because it spells out the fundamentals of practices to do mathematical modeling, bridging the gap between a ‘real world’ and a ‘conceptual world’. The context of reality is the ’real world’, which needs to be represented in mathematical models, removing ambiguities, to make systems consistent like the human mind. The ’conceptual world’ is translated by logical relationships. Both ’worlds’ must be integrated, in mutual relationship, in the models that describe an observed behavior or result. Therefore, the knowledge outlined here is fundamental to all the concepts and phases of the mathematical model, which makes us feel that mathematical modeling matches the core of cognition when establishing relationships and values in the construction of meanings. It is in this way that a model becomes a guidance on where to look, directing meaning and decision-making.

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