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Notes for an Epistemic Notion of Paraconsistency

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Abstract

In this paper we argue in favor of an epistemic way to understand paraconsistency. We briefly argue that examples like "It rains and it does not rain" are inadequate to defend the idea of an ontological inconsistency as a foundation for paraconsistent logic. Epistemic inconsistency centers its efforts on modeling the notion of paraconsistent inference rather than inconsistent statements. In this paper representation of statements is seen as depending on the inferential issue. We will center on the representation of a scientific theory and will defend that it requires the modeling of epistemic inconsistency. We do that by means of an analysis of empirical testing schemas, interpreting scientific hypothesis as fallible statements of a specific kind. Then paraconsistency must coexist with fallibility in an appropriate model representing scientific theories. Finally, we propose some very general characteristics, which, we consider, should be modeled on a logic of epistemic paraconsistency.

Keywords: epistemic paraconsistency, inconsistent science, falsifiability, scientific reasoning.

1 Introduction

The traditional conception considers logic as a representation of correct reasoning. Standard texts introduce it as the science of good reasoning, which characterizes it as a normative discipline. It is not a matter of how we reason but of how should we do so in order to reach the right conclusions. On the contrary, a naturalistic approach leaves aside the normative view focusing on the way in which we make inferences. The developments in artificial intelligence can be seen as normative or as a descriptive way of analyzing how to model the inferential processes so that they can be run by a Turing machine. The developments not only in artificial intelligence but also in philosophy have allowed the development of non-classical logics as formal systems. These systems must solve problems that do not arise in the case of an ideal reasoner (a non-existent omniscient individual with infinite time to make inferences). On the other hand, modeling in artificial intelligence faces problems[1] such as inference from incomplete information and the problem of changing beliefs, problems that standard logic does not pretend to solve. We think it is no longer a question of a representation of normative ideal inference but, at least partially, a representation of inference as it is, a representation of the way of arriving at conclusions as normal people do (the case of common sense modeling) or, at least, as an artificial agent would do with incomplete information. Artificial agents have an advantage over human beings: time. A human, in practical activities, usually does not have the time she would need to make the logical closure of her beliefs system. For example, a human being does not make the logical closure before traversing a street. A machine reasons more quickly. Speed is not, therefore, one of the factors to be simulated. What is central to simulate is the quality of the conclusions. That is to say, what logic is supposed to model is what follows from what (not how much time we need for reaching the conclusion).

2 The representation of inferences

The traditional conception considers logic as a representation of correct reasoning. Standard texts introduce it as the science of good reasoning, which characterizes it as a normative discipline. It is not a matter of how we reason but how should we do so in order to reach the right conclusions. On the contrary, a naturalistic approach leaves aside the normative view focusing on the way in which we make inferences. The developments in artificial intelligence can be seen as normative or as a descriptive way of analyzing how to model the inferential processes so that they can be run by a Turing machine. The developments not only in artificial intelligence but also in philosophy have allowed the great development of non-classical logics as formal systems. These systems must solve problems that do not arise in the case of an ideal reasoner (a non-existent omniscient individual with infinite time to make inferences). On the other hand, modeling in artificial intelligence faces problems such as inference from incomplete information and the problem of changing beliefs, problems that standard logic does not pretend to solve. We think it is no longer a question of a representation of normative ideal inference but, at least partially, a representation of inference as it is, a representation of the way of

[1] Two general ways to design artificial intelligence are the sub-symbolic approach and the symbolic approach. The first approach is not mainly oriented to knowledge representation. In this paper we will focus on the second approach, which is based on symbols, is mainly oriented to knowledge representation and, in general, supposes the information processing metaphor. For a connection between both aproaches see [1].

arriving at conclusions as normal people does (the case of common sense modeling) or, at least, as an artificial agent would do with incomplete information. Artificial agents have an advantage over human people: time. A human, in practical activities, usually does not have the time she would need to make the logical closure of her beliefs system. For example, a human being does not make the logical closure before traversing a street. A machine reasons more quickly. Speed is not, therefore, one of the factors to be simulated. What is central to simulate is the quality of the conclusions. That is to say, what logic is supposed to model is what follows from what (not how much time we need for reaching the conclusion).

3 The representation of data systems

A not so well-known function of logic[2] is the representation of data systems. If we are dealing with representing a scientific theory or a true description of the world, then the problem of the representation of starting point data may have been left aside for the following reason: A system of statements has both a strictly logical content and an empirical content. On the one hand, logical particles (connectives, quantifiers) do not seem to represent the world but connections related to its inferential function. On the other hand, statements of a scientific theory or, in general, of a description of the world have an empirical content that is irrelevant to any disquisition about its representation in a formal system. That is, the representation of, let's say the law "Enriched uranium spheres measure less than one mile" has, logically, the formal structure of a universally quantified conditional statement. This will allow some inferences and exclude others. In the system, non-logical notions remain as slots that sciences will fill in each case, and they lack internal structure. As long as the structure of statements has been linked with its inferential function, the interest in the representational function of starting point data in logical systems has gone unnoticed.

The subject comes to the fore when authors like Graham Priest assume a paraconsistent structure of the world.[3] His claim leads to a perception of the very representation of the universe, not only the inferences that we make from its representation, as something logically interesting. If the world is assumed to be contradictory then the following line of thought seems to be natural. If the world is contradictory the reason why a logical system must include contradictions is not principally that they allow or prevent certain inferences.

[2]One that [2], for example, accounts for.

[3]An example, but incomplete account of his position, is [3].

Contradiction must be accepted as a correct representation of reality, at least in cases when reality is contradictory. Then a second problem will be to see what follows from a set of data, but the first thing to propose is a correct representation of the world (a representation that includes inconsistencies, in Priest's view).[4]

This kind of assumptions must be seen in light of the distinction we have just proposed, that is, the distinction between representing an inference and representing a data system. The distinction is parallel to a more philosophical one, that between reality and a theory of reality. Modeling reality and modeling a theory about reality could be different tasks. Representing a theory could require (because of its inferential relations or because of something else) modeling contradictions even if a representation of reality does not force us to inconsistent structures.

Thus, some people would defend that, since reality is inconsistent, a representation of reality should be inconsistent too. An opposite approach is possible: Some people would like to defend that, since reality is consistent, we should not need a paraconsistent theory of reality. Ideally, a scientific theory or a representation of reality should present certain isomorphisms with reality. However, in the last sections of this paper we will argue that scientific theories generally require introducing factors (in particular, contradictions) even if we consider that the world does not contain them. We are not forced to infer contradictions in the world because of contradictions in the theory. Neither are we forced to infer consistency in the theory because of consistency in the world. Inconsistency could be, contrary to both alternatives, a property of theories because of its own intrinsic characteristics.

One thing is a formal representation of reality and another a representation of a theory. The last assertion could be considered obvious, but with regard to representations of reality, we wish to argue that, whether reality be consistent or not, the representation of a theory of reality should allow for inconsistency. With this aim in mind, in this paper we first will give an argument in favor of the existence of a certain way to eliminate contradictions in a particular way to think about reality. In second place, we will defend that in scientific

[4]Paul Wong in his [2] introduces highly instructive examples of the importance of representing inconsistencies in information systems. In particular, he demonstrates the fertility of modeling systems of conflicting interests by inconsistent representations. However, these models are not about real situations, but about inconsistent sets of options, that models try to optimize. The problem of whether or not the world is intrinsically inconsistent does not arise there.

empirical testing we have a similar kind of elimination of contradiction. In the third place, we will show that, even if we think of reality as consistent, we have theoretical cases that call for an inconsistent representation not of reality but of the theories that represent it.

These cases are built from our particular perspective of fallibility. This perspective is developed from an analysis of processes of empirical testing. Finally, based on a few intuitions about scientific work, we propose a list of characteristics to be included in modeling scientific theories, according to our perspective of fallibility constructed before. On this line of thought, whether the world is inconsistent or not, a useful representation of scientific theories must be able to express and handle inconsistencies with some particular characteristics.

4 About "p and not p". The case of an eliminable inconsistency

Let's suppose a contradiction like "It rains and it does not rain". We can assume it describes the world. After all, a rainy day is possible. The common notion of the passer-by allows us to say that it rains in the sense that at least a few drops fall, and that it does not rain, in the sense that there is no storm, just a drizzle. If we define the class of "rain" including light drizzles and "not rain", for practical purposes, as also including cases where, let's say, so few drops fall that we do not need umbrellas, then the statement "It rains and it does not rain" is true when there is hardly a drizzle. That, of course, does not depend on whether the world is contradictory but on how we decide to limit the "rain" and "not rain" classes. If we categorize them so that they have an overlapping scope then, when they overlap, both events will occur at the same time. We may call one the negation of the other if we like, but it is not in the sense in which when one of the facts occurs, the other does not occur. This is not, of course, the sense of negation in which one class excludes another, neither is it the case in which the description of one class is exactly the case that makes false the description of the other. In the last case we are in the presence of the usual logical negation, which is false when the proposition it is applied to is true, and vice versa. But, if we categorize classes so that they overlap, and if we suppose that the application of one is to be described as false when the other does truly apply, then we have a contradiction when we assume that they overlap. A contradiction like that of the rain does not appear as a property of the world but as a consequence of our way of delimiting classes. We think these last lines can be part of a defense against the demonstrability of inconsistency of the world, but it would be necessary to analyze other cases of contradictions. Nevertheless, we will not give that argumentation here. This is not an ontological question but depends only on a convention on the application of the categories and their limits. Had we determined classes differently the contradiction would not have arisen. These contradictions, at least contradictions like the one exemplified above, rest only upon the linguistic level and can be eliminated by linguistic conventions, too. There remains open the possibility of further cases where inconsistency could not be eliminable but our argumentation in the rest in this paper does not depend on denying them. Our reasons to suppose inconsistency in the level of theories will be independent on the ontological issue.

We will show now a case in empirical testing where we can eliminate the contradiction by means of an innovative interpretation strategy. This strategy leads us, we think, to a nonstandard interpretation of fallibility. Nevertheless, we will defend that, although we can get that specific kind of elimination successfully, we can leave open the possibility of another contradiction. We will be showing a case of inconsistency required at the theoretical level only by means of the proper epistemic conditions of the scientific representation of the world.

5 A kind of Falsifiability in Scientific Empirical Testing

The representations of the world are generally false, problematic, changing, and yet the product of our best effort to model it. In these conditions, what a logical system often must model is not the world but a scientific theory, that is, a representation of it as it has historically emerged in its scientific process of conformation. Then we proceed to present certain standard Hempelian schemas[5] of construction of scientific knowledge. From this modeling will emerge certain general characteristics of any formal representation of scientific theories with inconsistency and fallibility.

Let's consider the falsification of a theory and its logic according to Hempel's view. We can schematize it like this:[6]

$$(A)$$

[5] See [4].

[6] In the following schemas we allow the conditional symbol ("$\rightarrow$") to have sets in its left side. This union representation can be understood as an abbreviation of a sequence of logical conjunctions containing the members of those sets.

$$H \cup AH \cup IC \to OC$$

$$\neg OC$$

$$\overline{\neg(H \cup AH \cup IC)}$$

Where H is a unitary set of hypotheses, AH a set of auxiliary hypotheses, IC the initial conditions of the empirical testing and OC is a unitary set of observational consequences.

If the observational consequence contradicts experimental or observed facts there is something in the theory that must be changed. Then, as is well known in the philosophy of science, what follows from those premises is the denial of a conjunction, which amounts to a disjunction of negations:

$$\neg H \vee \neg AH_1 \vee \neg AH_2 \vee, \ldots, \vee \neg AH_n \vee \neg IC_1 \vee \neg IC_2 \vee, \ldots, \vee \neg IC_n$$

which we will abbreviate as:

$$\neg H \vee \neg AH_{1 \ldots n} \vee \neg IC_{1 \ldots n}$$

So if the scientist wants to find out if the hypothesis is true, she first makes sure that the initial conditions (IC_i) were performed correctly. If she is sure that they were, she will try to change some auxiliary hypotheses (AH_i), but if she is sure of everything else, she will conclude that the hypothesis (H) is false. All this requires research processes circumscribed only within a standard logic. Considering abbreviations analogous to the last one, the schema B represents the result of the description in this paragraph:

$$(B)$$

$$H \cup AH \cup IC \to OC$$

$$\neg OC$$

$$AH_{1 \ldots n} \wedge IC_{1 \ldots n}$$

$$\overline{\neg H}$$

However, taking only the schemas A and B in consideration, there is no contradiction because the hypothesis (H) has not been asserted but included as antecedent of a conditional statement. Nevertheless, usually this kind of fallibility brings with it a contradiction in the general corpus of the theory.

Usually, at the time when the scientist finds a refutation to the hypothesis (H), it has been already accepted in the theoretical corpus because of several confirming cases in favor of the hypothesis that had been obtained before. Schema C represents this particular case:

$$(C)$$

$$T = \{H, AH_{1\ldots n}, \ldots\}$$

$$H \cup AH_1 \cup IC_1 \rightarrow OC$$

$$\neg OC$$

$$AH_{1\ldots n} \wedge IC_{1\ldots n}$$

$$\neg H$$

where T is a theory and $H, AH_{1\ldots n}, \ldots$ the hypothesis belonging to it.

In the case described in C, we have a contradiction. Specifically, if we understand H as a universal proposition, $\neg OC$ can be taken as a negation of a singular statement that contradicts H. We have a contradiction between a universal conditional statement and a singular conjunction. Therefore, from the classical logic point of view, we can infer anything from the premises of C: The theory explodes. Here we have, at least at the theoretical level, an authentic case of P and Not P.

However, we can propose a re-interpretation of the situation we have just stated in order to eliminate the contradiction. An alternative view, also accepted by Hempel, is that sometimes we prefer not to abandon AH, IC or H. Instead, we can accept that H has, in Hempel's words, "provisos".[7] He thinks that there are boundary conditions that are required, "normal" conditions (NC) as we shall call them, which may not be met. Considering NC as a set of that kind of conditions, the inference is no longer the former but that of the schema D:

[7] See [5].

$$(D)$$

$$T$$

$$H \cup AH \cup IC \cup NC \rightarrow OC$$

$$\neg OC$$

$$\neg(H \cup AH \cup IC \cup NC)$$

Hempel is aware that conditions of normality cannot, in general, be established in advance. On the contrary they must be assumed as an infinite non-specifiable class. He considers it as an unsolvable obstacle to represent the main functions of Science.

Against Hempel's consideration, we assume that scientists proceed in a very different manner. What the scientist plausibly does is to consider that these normal conditions are fulfilled, unless proven otherwise.

Our last assumption in the above paragraph accords well with the development of non-monotonic logics, logics in which it is possible to retract some conclusions, given further information about the case.[8] As an illustration, it is worth noting that some of these logics introduce the concept of exception: The inference is effectively done, in these systems, only if no exception to the particular case (referred in the premises) occurs. These logics do not support the known principle of monotonicity (which is central in classical logic). From the structural approach, that principle can be described as follows:

$$(M)$$

$$\text{If } \Gamma \Rightarrow \alpha, \text{ then } \Gamma \cup \Delta \Rightarrow \alpha$$

where Γ, Δ are any sets of propositions, α is any proposition, and $\Rightarrow$ is a kind of semantic or syntactic metalogic consequence relation.

Taking these kind of logics in consideration, we can interpret differently the conditional or a quantifier included in a universal proposition H and then we can eliminate the contradiction supposed in the schema C.

[8]Pioneer texts are [6], [7], [8] and [9].

Let us show this in detail. Suppose we have assessed auxiliary hypotheses and initial conditions and we have found them correct. The observational consequence does not occur. However we do not infer immediately, as classical logic would conclude, $\neg H \vee \neg CN_{1\ldots n}$ Only if we assume that there are conditions of normality we infer that the hypothesis is false.

This inference is no longer a classical one, and the notion of derivability must be defined differently. A characteristic of this notion of derivability will be the property of non-monotonicity. Structurally:

$$(NM)$$

$$\Gamma \Rightarrow \alpha, \text{ and it is possible that } \Gamma \cup \Delta \Rightarrow \alpha \text{ does not occur.}$$

Coherently with NM, we add the subscript nm indicating a non-monotonic inference relation in the next schema E:

$$(E)$$

$$\frac{\begin{array}{c} T \\ H^F \cup AH \cup IC \cup NC \rightarrow OC \\ IC \\ AH \\ \neg OC \end{array}}{\neg H^F}\, nm$$

This schema can be read as follows: In the context of the theory T let's suppose a hypothesis or scientific law (H^F) is given, reinterpreted as a proposition with a certain kind of fallibility (for example re-interpreting the conditional as a probabilistic conditional, or re-interpreting the quantifier as "almost always"). Initial conditions (IC) and auxiliary hypotheses (AH) are satisfied and yet the observational consequence does not occur ($\neg OC$). Then, we can infer under normal conditions that the hypothesis (H^F) has to be wrong. Note that conditions of normality (NC) are not required in the premises because they are assumed, unless proven otherwise. That makes the inference non deductive, $\neg H^F$ follows even though NC does not figure among premises. Several important variants of non-monotonic logics take in consideration an inferential mechanism that includes some form analogous to the idea of conditions of normality.

According to our approach, we do not need that these conditions of normality be verified in reality. It is sufficient that at the level of the representation, in the theoretical level, these conditions be asserted within the theory or within the context of its interaction with the cases of empirical testing.

Let's note that, in the case described by schema E, we do not have a contradiction any more. Although we accept $\neg OC$ and we assume $H^F \subseteq T$, we do not consider as a contradiction the conjunction $\neg OC \wedge H^F$, because of the re-interpretation of H contained in our new H^F: this is the interpretation in which, in the light of our approach, in this particular case in empirical testing, P and Not P disappear. This interpretation supposes that we do not know each specific case of normality. If OC were specified as a case of normality, we would have concluded that $H^F \wedge \neg OC$ can be a contradiction. This interpretation is also possible in non-monotonic logics.

In our interpretation, if we eventually discover a condition of abnormality, for example, that there is a force field intervening that we had not noticed, then we have the right to add a premise to the previous ones establishing this fact, with the addition of which the negation of the hypothesis no longer follows.

$$(F)$$

$$T$$

$$H^F \cup AH \cup IC \cup NC \rightarrow OC$$

$$IC$$

$$AH$$

$$\neg OC$$

$\neg NC_i$ (There is an abnormality condition i)

From these conditions, $\neg H^F$ does not follow.

Inference is canceled with the addition of new information $\neg NC_i$ as a premise (non-monotonicity). Actually this new information could be more complex than what appears in schema F. It could be additional information that results in propositions inferred from the context of the system and from a data system. These propositions would activate a mechanism that cancel the inference of $\neg H^F$.

It is interesting that assuming a fallible hypothesis H^F contraposition from the denial of OC to denial of the set including H^F becomes invalid:

Although we have $H^F \cup AH \cup IC \cup NC \to OC$

We do not have necessarily $\neg OC \to \neg(H^F \cup AH \cup IC \cup NC)$

The intuitive reason of this characteristic could be better understood if we assume a weaker quantification in HF. We can think of the quantifier as "most As are Bs" and not as "every A is B". This weaker interpretation can help us visualize that there exists a zone in the As that are not Bs. Then if we find a case of not B, that fact does not guarantee that it is a case of not A: Saying that "most As are Bs" is not the same as saying that "Most non Bs are non As".[9]

An important consequence of our approach of fallibility in H^F is that the assumption of normality makes it difficult to model falsification. Whenever a counterexample appears, it is logically possible to argue that it is not a falsification but an exception or a case of abnormality. However, from the epistemic point of view it is convenient to understand what counts as an abnormality in order to cancel the falsification. If there is nothing to suspect abnormality then what follows is that the hypothesis has to be wrong. Thus, a retractable falsifiability is recovered.

6 Inconsistency recovered and some intuitions about it

It is worth noting that recovering falsifiability does not mean recovering an algorithm to decide to refuse the hypothesis. This remark is very important to be kept in mind. At the theoretical level, contradictions can re-emerge as a coexistence between P and $\neg P$, given evidence in favor of both propositions, where P and $\neg P$ are H^F and $\neg H^F$ respectively. We can imagine that we have evidence to assert both H^F, contained in T, and $\neg H^F$ obtained by means of the empirical testing.

[9]For another cases of formal properties of non monotonic inference, see [10]. Specially for this explanation, we are considering the diagram in p. 41, that is very illustrative.

But, what happens to scientific inference when something is falsified? Let us mention some intuitions about what we consider the epistemic point of view of a scientist in this situation. The scientist does not seem to handle the contradiction with the tools of classical logic. Many scientists say that the hypothesis isn't discarded immediately, but theory holds, the denial of observational consequence holds, considered an anomaly[10], and both coexist. Then we have a theory T that we accept along with their $\neg OC$. Considering H, and assuming the conclusions of the empirical test, we would have that $T \cup AH \cup IC \cup OC$ is contradictory.

In the first place, when the scientist finds a contradiction, she does not infer every proposition of the underlying language of $T \cup AH \cup IC \cup OC$, i.e., she does not consider that her theory explodes. In the second place, finding a contradiction does not seem to mean that the scientist considers the hypothesis (H^F) true even though OC is false. She normally considers that something is wrong with the theory and the need for a solution arises. Eventually she will modify something in the theory that will make everything fit. One of those modifications could result in giving up the hypothesis. It is worth noting that even in the intermediate period in which things "are not going well" the scientist does not assume that everything is true. On the contrary, she knows very well that the set $T \cup AH \cup IC \cup OC$ is inconsistent with $\neg H^F$ and works on it to solve the problem. This intuitive scientific attitude can be called "an epistemic transitory paraconsistency situation" and can be resumed in three items:

1) The scientists do not infer everything from a contradiction.
2) The scientists do not consider a contradiction as a true proposition.
3) The scientists try to dissolve the contradictions.

7 Final Reflections

All this analysis and the corresponding perspective to understand the non-monotonic kind of fallibility in the scientific hypothesis, we think, provide an idea for modeling a scientific theory by means of what we call an "epistemic paraconsistent logic". We propose, in conclusion, that a model of scientific theories must include the following non-exhaustive characteristics:

1) It must allow for retractable statements.[11]

[10] [11].

[11] For an analysis of non-monotonicity we refer to [12] and [13].

2) It must allow for inconsistent formulae.

3) Contradictions in the model are not supposed necessarily to represent the world. Otherwise scientists would not be trying to exclude them, as they do in fact in case of falsification. [12]

4) It must capture the idea of an approach in which a) the scientist does not infer everything from a contradiction; b) even within the framework of an inconsistent theory, not everything can be equally inferred. Some things follow, some things don't. That is to say, inconsistency—as it is meant in any paraconsistent conception—should not imply triviality. The resources of the current alternatives in paraconsistency all avoid this implication.

5) It should have the capability to weaken the inferential power of contradictions.

6) It cannot simply assume that contradictions are true. It should not consider the contradiction as taken as quasi-true value either. The scientist knows there is something false in there, but she does not know what it is.

7) It should capture a kind of strategy to fix the inferential paths to find out where the falsity is, in order to, finally, eliminate the contradiction. That is, paraconsistent logic is not only supposed to avoid some classical inferences (explosiveness) but, in particular, to determine what can be inferred and how. A notion of paraconsistent inference should be aimed at elucidating the rational process of yielding consequences in paraconsistent systems, consequences that would eventually serve as potential falsifiers to eliminate the factor that produces the contradiction.

Our general approach deals with inconsistencies at a theoretical level, independently of the question about the consistency of the world. With this perspective we have more freedom to deal with interpretations of inconsistencies in scientific theories. We think that this general approach and, consequently, requirements 1-7 laid down above will contribute to a better theoretical representation of inconsistencies in science. Therefore, a paraconsistent logic designed to model scientific theories, from this perspective, would be more closed related with the real work in science. In addition, we argued that inconsistencies should coexist with fallible statements so a paraconsistent and fallible

[12] The Brazilian school can be understood as modeling some kind of epistemic inconsistency. See, for example, [14] and [15]. More recently, in a very different approach respect to that of us, [16].

modeling is needed. In a future work, it would be important to establish specific formal strategies to deal with inconsistencies in a model for a scientific theory. In particular, we think it is very important to capture, among other issues: interpretations of laws, explanations and arguments. On the other hand, it would be important to explore ways to identify contradictions and their components in order to eliminate or isolate somehow the contradiction, avoiding, this way, its dangerous consequences for scientific inference. We are working on it.

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References

[1] P. Gardenfors, Conceptual Spaces as Framework for Knowledge Representation. *Mind an Matter*, Vol. 2(2):9–27, 2004.

[2] P. Wong, Reasoning and modelling: Two Views of Inconsistency Handling. In J. Y. Béziau, W. Carnielli, D. Gabbay, *Handbook of Paraconsistency, Studies in Logic. Logic and Cognitive Systems*, Vol 9, Individual author and College Publications, 2007.

[3] G. Priest, *Beyond the Limits of Thought*, Cambridge University Press, UK, 2003.

[4] C. Hempel, *Philosophy of Natural Science*, Prentice-Hall, New Jersey, 1966.

[5] C. Hempel, Provisoes: A Problem Concerning the Inferential Function of Scientific Theories. *Erkenntnis*, 28:147–164, 1988.

[6] J. McCarthy, and P. Hayes, Some Philosophical Problems from the Standpoint of Artificial Intelligence. In B. Meltzer y D. Michie (Eds.), *It Machine Intelligence*, Vol. 4, Edinburgh University Press, Edinburgh-New York, 1969.

[7] J. McCarthy, Epistemological Problems of Artificial Intelligence, *International Joint Conference on Artificial Intelligence*, 1977.

[8] R. Reiter, A Logic for Default Reasoning, *Artificial Intelligence*, Vol. 13, 1980.

[9] D. McDermott and J. Doyle, Non-monotonic Logic, *Artificial Intelligence*, Vol 13(1-2), 1980.

[10] R. Morado, *Fault Tolerant Reasoning*, PhD Thesis, Indiana University, USA, 1994.

[11] T. S. Kuhn, *The Structure of Scientific Revolutions*, International Encyclopedia of Unified Science, The University of Chicago, First edition, 1962. Second Edition enlarged, 1970.

[12] R. Morado, Filosofía de las lógicas no monotónicas. In R. Orayen, A. Moretti (eds.), *Filosofía de la Lógica*, Enciclopedia Iberoamericana de Filosofía, Vol 27, Trotta, Spain, 2004.

[13] D. Gaytán and M. A. Pazos, Introduction, in their book: D. Gaytán and M. A. Pazos, (eds.), *Ciencia Falible: reflexiones lógico-filosóficas sobre aplicaciones de lógica no monotónica*, Fontamara-UACM, Mexico, in press.

[14] N.C.A. Da Costa, On the Theory of Inconsistent Formal Systems, *Notre Dame Journal of Formal Logic*, Vol 15(4), 1974.

[15] I. M. L. D'Ottaviano, On the Development of Paraconsistent Logic and da Costa's Work, *The Journal of Non-Classical Logic*, Vol. 7(1-2), 1990.

[16] W. Carnielli and J. Marcos, A Taxonomy of C-systems. In W. Carnielli, M. Coniglio, I. M. L. D'Ottaviano (eds), *The Logical Way to the Inconsistent. Proceedings of the World Congress of Paraconsistency*, Sao Paulo, Brazil, 2000.

[17] W. Carnielli and A. Rodrigues, An epistemic approach to Paraconsistency: A Logic of Evidence and Truth, *Synthese*, Vol. 196:3789–3813, 2017.

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