Chapter 5
Cognitive-Constructivism, Quine, Dogmas of Empiricism, and Münchhausen's Trilemma

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Abstract The Bayesian research group at University of São Paulo has been exploring a specific version of Cognitive Constructivism – Cog-Con – that has, among its most salient features, a distinctive objective character. Cog-Con is supported by a specially designed measure of statistical significance, namely, $\mathrm{ev}(H\,|\,X)$ – the Bayesian epistemic value of sharp hypotheses H, given the observed data X. This article explores possible parallels or contrasts between Cog-Con and the epistemological framework developed by the philosopher Willard van Orman Quine.

A gente vive repetido, o repetido... Digo: O real não está na saída
nem na chegada: Ele se dispõem para a gente é no meio da travessia.
...Existe é homem humano. Travessia.
João Guimarães Rosa (1908-1967); Grande Sertão, Veredas.

We live repeating the repeated... I say: What's real can be found neither
at departure nor upon arrival: It only becomes available during the journey.
...What exists is the living man; Crossing-over.

Warum ist Wahrheit fern und weit? Birgt sich hinab in tiefste Gründe?
Niemand versteht zur rechten Zeit! Wenn man zur rechten Zeit verstünde,
So wäre Wahrheit nah und breit, Und wäre lieblich und gelinde.
Goethe (1749-1832); Westöstlicher Diwan. As quoted in Rosenzweig (1921).

Why is truth so remote and far away? Down at the deepest bottom hold astray?
Nobody understands its proper time! If, however, in its due time understood;
Then truth would be close and sublime; And would be graceful and good.

...the idea of circularity: That's where everything begins.
Heinz von Foerster (1911-2002); Understanding Systems.

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5.1 Introduction

For the last 18 years, the Bayesian research group of IME-USP – The Institute of Mathematics and Statistics of the University of São Paulo, has been exploring a specific version of Cognitive Constructivism – Cog-Con – that has among its most salient features a distinctive objective character and the support of specially designed tools of Bayesian Statistics.

In previous presentations about the Cog-Con epistemological framework, for audiences with interests spanning Logic and Epistemology, foundations of Bayesian Statistics, and foundations of science, we were asked several questions concerning possible parallels or contrasts between Cog-Con and the epistemological framework developed by the philosopher Willard van Orman Quine. This article begins to explore this topic.

Section 2 gives a succinct overview of Cog-Con – the Cognitive Constructivist epistemological framework used in this article. The following sections explore similarities and differences between Cog-Con and Quine's epistemological frameworks. Section 3 analyzes the *Two Dogmas of Empiricism* denounced by Quine, as well as the *Third Dogma* proposed by Davidson, making some parallels between Cog-Con and Quine's epistemological frameworks. Section 4 contrasts the two frameworks on their respective strategies to anchor a scientific theory to reality. Section 5 uses the Münchhausen Trilemma to continue the comparative analysis of the two frameworks, while Section 6 compares them on the role played by Ontology and Metaphysics. Section 7 brings our final remarks.

5.2 Objects as Tokens for Eigen-Solutions

Eigen-solution is the key concept of the objective version of cognitive constructivism used in this article. Eigen-solutions emerge as invariant entities (that is, as operational eigen- equilibrium- invariant- fixed-... -solutions -states -behaviors -points) for an autonomous system interacting with its environment. The fundamental insight of this epistemological framework is summarized by the celebrated aphorism of Heinz von Foerster – *Objects are tokens for eigen-solutions*. In other words, objects, and the names we use to call them, stand for and point at such invariant entities, see Foerster (2003), and Segal (2001, p.127, p.145).

In Cognitive Constructivism, the concept of autonomy can be further specified using the idea of concrete or abstract *autopoietic system* – a system organized as a network of processes of production of components that, through their interactions and transformations, recursively regenerate the same production network and its constituent components, see Maturana and Varela (1980, p.78).

As possible examples of an autonomous interacting system in its respective environment, we may consider a bacteria in its culture medium, a human individual living in his or her social environment, or a scientific discipline and its field of study, that is, the discipline's standard language, theories, empirical means and methods,

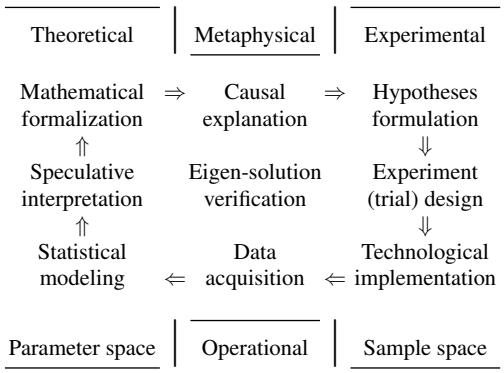

Figure 1: Scientific production diagram.

experimental tools and equipment, etc., that have been developed for the continuous research of its area of expertise.

Figure 1 depicts a generic diagram of systemic interaction for a scientific discipline. The right side of the square depicts activities related to empirical trial or experiment design and implementation; The lower side depicts operations related to data observation, generation, acquisition and analysis; The left side relates to theoretical modeling and formalization; Finally, the upper side relates to metaphysics: the conception and application of causal mechanisms, explaining why things behave the way they do. In statistical models, observable quantities of interest are represented by (stochastic) variables in the sample space, while latent (unobservable) quantities of interest are represented by variables in the parameter space.

Eigen-solutions can be tagged or labeled by words, and these words can be articulated in language. Of course, the articulation rules defined for a given language, its grammar and semantics, only make the language useful if they somehow correspond to the composition rules for the objects the words stand for. Ontologies are carefully controlled languages used in the practice of science. They are developed as tools for procedure specification, thinking and communication. According to the constructivist perspective, key words in scientific ontologies are labels for eigen-solutions. This is the constructivist approach to the classic problem of external symbol grounding and alignment of scientific ontologies, as discussed in Stern (2014).

Eigen-solutions are characterized by four essential attributes, namely, *precision, stability, separability and composability*. Depending on context, precision is better described as sharpness, lower-dimensionality, discreetness, singularity, etc. In several well-known examples in exact sciences, these four essential attributes lead to the concept of basis, for example: basis of a finite vector space, like in linear algebra; basis of a Hilbert space, like in Fourier or Wavelet analysis; etc. Nevertheless, the concept of eigen-solution and its four essential attributes is so important in the Cog-Con framework, that it is used as a fundamental metaphor in far more general, and not necessarily formalized, contexts.

In the context of Statistics, the essential attributes of eigen-solutions makes them amenable for representation as statements of a very special form, namely, sharp or precise hypotheses. A hypothesis $H = \{\theta \in \Theta \,|\, g(\theta) \leq 0 \wedge h(\theta) = 0\}$, states that the (continuous vector) parameter θ of a statistical model lays in a region of the parameter space specified by (vector) inequalities and equality constraints; Sharp hypotheses must have at least one equality constraint. The treatment of sharp statistical hypotheses, in turn, is far from trivial, demanding the employment of suitable mathematical techniques and requiring the use of coherent methods of inference.

For the last 18 years, the Bayesian Statistics research group of IME-USP, at the University of São Paulo, has been developing a significance measure known as the e-value – the epistemic value of a sharp or precise statistical hypotheses H, given the observational data X or, in short, $\text{ev}(H\,|\,X)$; see Madruga et al. (2001), Pereira and Stern (1999) and Pereira et al. (2008). At the same time, we have been exploring the strong algebraic properties for composition of e-values, and the characterization of these rules for combination and propagation of truth-functions and truth-values as abstract belief calculi or logical inferential systems, see Borges and Stern (2007), Stern (2004), and Stern and Pereira (2014). These algebraic rules or logical properties further reflect essential compositional properties of the underlying (or represented) eigen-solutions. Furthermore, we have been developing Cog-Con as a suitable epistemological counterpart for this novel statistical theory, and vice-versa, see Stern (2007a,b, 2008a,b, 2011a,b, 2014).

5.3 Parallels between Cognitive Constructivism and Quine's Epistemological Frameworks

In the opening paragraph of his famous paper of 1951, Willard van Orman Quine denounces *Two Dogmas of Empiricism*, as stated in the first of the following quotations. In 1974, Donald Davidson denounced what he saw as a third dogma, as stated in the second quotation. However, as stated in the third quotation, after carefully constraining the context and scope of his argument, see further comments on Section 6, Quine accepts as necessary the premise of scheme-content dualism.

> *Modern empiricism has been conditioned in large part by two dogmas. One is a belief in some fundamental cleavage between truths which are* analytic*, or grounded in meanings independently of matters of fact and truths which are* synthetic*, or grounded in fact. The other dogma is* reductionism*: the belief that each meaningful statement is equivalent to some logical construct upon terms which refer to immediate experience. Both dogmas, I shall argue, are ill founded. One effect of abandoning them is, as we shall see, a blurring of the supposed boundary between speculative metaphysics and natural science. Another effect is a shift toward pragmatism.* Quine (1953, p.20).

> *I want to urge that this... dualism of scheme and content, of organizing system and something waiting to be organized, cannot be made intelligible and defensible. It is itself a dogma of empiricism, the third dogma. The third, and perhaps the last, for if we give it up it is not clear that there is anything distinctive left to call empiricism.* Davidson (1974, p.11).

> *If empiricism is construed as a theory of truth, then what Davidson imputes to it as a third dogma is rightly imputed and rightly renounced... As a theory of evidence, however, empiricism remains with us, minus indeed the two old dogmas. The third purported dogma, understood now in relation not to truth but to warranted belief, remains intact. It has both a descriptive and a normative aspect, and in neither do I think of it as a dogma. It is what makes scientific method partly empirical rather than solely a quest for internal coherence.* Quine (1981a, p.39).

Closely related to rejecting the first dogma, analytic-synthetic dualism, is Quine's idea of *naturalism*, namely,

> *...the recognition that it is within science itself, and not in some prior philosophy, that reality is properly to be identified and described.* Quine (1981a, p.21).

Closely related to rejecting the second dogma, reductionism, is Quine's idea of *confirmational holism*, stated as follows:

> *The totality of our so-called knowledge or beliefs... is a man-made fabric which impinges on experience only along the edges. Or, to change the figure, total science is like a field of force whose boundary conditions are experience. A conflict with experience at the periphery occasions readjustments in the interior of the field. But the total field is so undetermined by its boundary conditions, experience, that there is much latitude of choice as to what statements to re-evaluate in the light of any single contrary experience. No particular experiences are linked with any particular statements in the interior of the field, except indirectly through considerations of equilibrium affecting the field as a whole.* Quine (1953, p.42-43).

In summary, Quine's epistemological framework involves the following five interconnected premises.

1. Rejection of *analytic-synthetic dualism*;
2. Rejection of *reductionism*;
3. Acceptance of *scheme-content dualism*;
4. Acceptance of *naturalism*; and
5. Acceptance of *confirmational holism*.

We believe that these five premises account for most of the similarities often perceived between Cog-Con and Quine's epistemological frameworks, and with good reason indeed.

Let us start with a comparative examination of Quine's third premise in relation to the Cog-Con framework. Cog-Con departing point is the existence of a concrete or abstract autonomous system interacting with its environment. Of course, a clear distinction between the system itself, including its characteristic features or internal organization, versus an external environment and its inherent form, that is, the structural constraints of the system's domain, range or scope of interaction, is a necessary condition for analyzing such an interaction process. Hence, we immediately correlate Cog-Con's *system-environment* distinction with *scheme-content* dualism.

Let us proceed asserting that, in the Cog-Con framework, Mathematics is regarded as a *quasi-empirical science*, using a terminology developed by the philosopher Imre Lakatos, see Lakatos (1976, 1978) and Szabó (1978). For a detailed analysis of this concept, in the context of the Cog-Con framework, see Stern (2011a). For the purposes of this article, it suffices to say that mathematics as a quasi-empirical

science is an idea consonant with Quine's premises of rejecting analytic-synthetic dualism and accepting naturalism.

Finally, let us turn our attention to Figure 1, depicting the *Scientific production diagram*. From this diagram, we see that the production of eigen-solutions in the practice of science depends not only on the pertinent scientific theory as a whole, but also on the necessary technological means, on appropriate methods of experiment design and data analysis, etc. Clearly, these ideas are in accord with Quine's premises of rejecting reductionism and accepting confirmational holism. Hence, concerning the five premises examined in this section, we find Cog-Con and Quine's epistemological frameworks in comprehensive agreement.

Before ending this section, we should emphasize that, in both of the epistemological frameworks at hand, rejection of reductionism and acceptance of confirmational holism does not conflict with the concept of having testable statements somehow inserted in the fabric of scientific knowledge. However, there are important differences on the form, role and position of such testable statements according to each of the two epistemological frameworks, as examined in the following sections.

5.4 Contrasting Strategies Against Skepticism

The holistic perspective, pre-eminent either in Quine's or in the the Cog-Con frameworks, brings the danger of vicious circularity that, in turn, easily leads to skepticism. Hence, in both of these frameworks, it is important to defeat skepticism. Specifically, it is important to carefully explain how to anchor the theory and methods of a scientific discipline into *reality*. Contrasting the two epistemological frameworks' strategies for defeating skepticism, we find the main differences between the two approaches. Let us start analyzing the short but very dense *Reply to Stroud* in Quine (1981b).

Stroud (1981, p.457) raises some questions concerning – *the possibility that the world is completely different in general from the way our sensory impacts and our internal makeup lead us to think of it.*

Quine (1981b, p.473-474) gives his reply in three basic steps, namely:

- First, he assumes – *an inclusive theory of the world, regimented in the framework of predicate logic*;
- Next, using the standard tools of Predicate Logic, he – *view[s] this [Stroud's] possibility in the perspective of proxy functions and displaced ontologies*;
- Finally, after appropriate manipulation and reinterpretation of predicative statements, he comes to the conclusion that:

> *The structure of our theory of the world will remain unchanged. Even its links to observational evidence will remain undisturbed, for the observation sentences are conditioned holophrastically to stimulations, irrespective of any reshuffling of objective reference.*
>
> *Once we take observation sentences holophrastically, however, reference and objects generally go theoretical. The indifference or inscrutability of ontology comes to apply across the board.*

> *The relations of language to stimulations are unaffected by any shift of our ontology through proxy functions. Evidently then such shifts are indifferent to use, to meaning. The platitude that meaning determines reference goes by the board, along with the absoluteness of reference. The objects, or values of variables, serve only as nodes in a verbal network whose* termini a quis et ad quos *are observations, stimulatory occasions.*

Quine's arguments in his answer to Stroud depend critically on two additional (and explicit) premises:

6-Quine. Acceptance of a *predicate logic structure*, that is, assuming that Predicate Logic (or similar belief calculi) gives the symbolic structure of choice for the *regimentation* of science.
7-Quine. Acceptance of the *finite regress* premise, that is, to assume the availability of terminal nodes when parsing down well-formulated truth-bearing statements within the scope a well-regimented theory. In Quine's framework, these terminal or bottom nodes come in the form of – observation sentences, conditioned holophrastically to stimulations. (In Logic and Computer Science, the standard representation of this parsing process is a tree structure having its starting node or root at the top and its terminal nodes or leaves at the bottom.)

In contrast, in the Cog-Con framework, these two additional premises are replaced by alternatives of a very different nature, namely,

6-Cog-Con. Acceptance of a *statistical model structure*, that is, assuming that Probability and Mathematical Statistics (or alternative models based on similar belief calculi), gives a symbolic structure of choice for testing operations (verification / falsification) in empirical science.
7-Cog-Con. Acceptance of *objects as tokens for eigen-solutions* – invariants or fixed-points in essentially cyclic and recursively defined processes.

Furthermore, the premises of *objects as tokens for eigen-solutions* and *statistical model structure* are linked by assuming the availability of *sharp statistical hypotheses* as check points in well-posed scientific disciplines. Successful (statistical) testing of such sharp hypotheses implies an *evaluation of objectivity* (or verification of *existence*), for a corresponding set of objects in the pertinent scientific ontology.

Statistical models make use of real vector variables for representing observed quantities or latent parameters. Moreover, in such models, learning (ex. Bayesian updates) and (stochastic) convergence properties are appropriately described by continuous mathematics, in sharp contrast with the discrete character of propositional logic.

The contrasting assumptions examined so far in Cog-Con and Quine's epistemological frameworks are also related to the perceived position, from a central to peripheral range, of the testable statements in scientific knowledge. For Quine, these contact-points with reality have a peripheral position, as clearly stated in his analogy of scientific knowledge to *a man-made fabric which impinges on experience only along the edges*, Quine (1953, p.42). In contrast, the Cog-Con framework relates its testable hypotheses to valid of eigen-solutions, entities that, by their very nature, are perceived as deeply (and recursively) embedded in systemic activity. We believe that this topic can be further elucidated studying the Münchhausen Trilemma.

5.5 Münchhausen Trilemma

The difference between adopting the premise of *finite regress*, in Quine's approach to epistemology, and adopting the premise of *objects as tokens for eigen-solutions*, in the Cog-Con epistemological framework, may be seen as a consequence of choosing different horns of the celebrated Münchhausen trilemma, as it was formulated by Hans Albert (1985, p.18):

> *If one demands a justification for everything, one must also demand a justification for the knowledge to which one has referred back the views initially requiring foundation. This leads to a situation with three alternatives, all of which appear unacceptable: in other words, to a trilemma which, in view of the analogy existing between our problem and the one which the celebrated and mendacious baron once had to solve, I should like to call the Münchhausen trilemma. For, obviously, one must choose here between*
> *(a) an infinite regress, which seems to arise from the necessity to go further and further back in the search for foundations, and which, since it is in practice impossible, affords no secure basis;*
> *(b) a logical circle in the deduction, which arises because, in the process of justification, statements are used which were characterized before as in need of foundations, so that they can provide no secure basis; and, finally,*
> *(c) the breaking-off of the process at a particular point, which, admittedly, can always be done in principle, but involves an arbitrary suspension of the principle of sufficient justification.*

Of course, each epistemological framework must deal with the perils of its favorite (or least feared) horn of Münchhausen trilemma:

- Quine must show how to achieve a finite break-off when parsing down well-posed truth-bearing statements formulated in the scope of a theory regimented according to his chosen symbolic structure, namely, Predicate Logic.
- In our opinion, Quine should also accomplish the far more difficult task of convincing his potential clientele that his choices 6 and 7, namely, his premises of Predicate Logic structure and finite regress, are the most appropriate for the (naturalized) epistemological task of verifying and evaluating scientific theories. Furthermore, from the same naturalistic perspective, it would be very helpful if the same choices were also the most suitable for use in active duty by scientists trying to test or validate their empirical models and working hypothesis.

Of course, the proponents of the Cog-Con framework must also justify their choices 6 and 7. In particular it is vital to:

- Justify abandoning Predicate Logic as the single belief calculus used for epistemological reasoning, that is, the only set of rules used for truth analysis and propagation in the evaluation of scientific models, and the introduction of continuous logics or belief calculi such as Probability or Possibility theory. The introduction of new belief calculi requires careful argumentation, since Predicate Logic and its variants have a long-standing tradition of playing all alone the aforementioned role in many frameworks for epistemology and philosophy of science.

- Show how to tame the circularity looming at horn (b) of Münchhausen trilemma into a virtuous form, for vicious forms of circularity threaten to poison the health of any epistemological framework, and hand over victory to skepticism.

Quine himself, and many of his followers, have worked extensively in the aforementioned tasks. Although cognitive constructivism in general, and the objective version of it used in this article in particular, are much younger, presumably only beginning their development, several already published theoretical results and practical applications show how these tasks can be successfully accomplished.

Ultimately, it will be up to the user to choose the framework that he or she considers the most natural, intuitive and well-adapted to its field of interest. In the case of Cog-Con, the available or required mathematical tools may have an influence in this choice. On one hand, statistics is (or should be) a well-known tool of the trade for the working scientist. On the other hand, the abstract representation of virtuous forms of circularity is a far less common task.

Nonetheles, some fields, most specially computer science, have developed powerful formalisms for the abstract representation of essentially circular processes that produce, nevertheless, well-defined objects. Some non-standard logics and set theories are, in fact, mathematical tools tailor-made for the logical representation of such recursively defined objects. As interesting examples, we could mention Hypersets or Non-Well-Founded Set Theory and its derivatives, see for example Aczel (1988), Akman and Pakkan (1996), Barwise and Etchemendy (1987, Ch.3), Barwise and Moss (1996), and Devlin (1994, Ch.7).

5.6 Ontology and Metaphysics

Once again, we start noticing striking similarities between Cog-Con and Quines's frameworks at important departing points, followed by significant differences in their evolution. The common departing point we have in mind is the relation between ontology (understood as studies on what there is) and language, as stated in Quine (1953, p.16):

> *Our acceptance of an ontology is, I think, similar in principle to our acceptance of a scientific theory, say a system of physics: we adopt, at least insofar as we are reasonable, the simplest conceptual scheme into which the disordered fragments of raw experience can be fitted and arranged... To whatever extent the adoption of any system of scientific theory may be said to be a matter of language, the same-but no more-may be said of the adoption of an ontology.*

As seen in Section 2, from the Cog-Con perspective, ontologies are carefully controlled languages used in the practice of science, developed as tools for procedural description and specification, theoretical reasoning and communication. A scientific ontology includes a (formal) definition of the collection of objects of knowledge of a given scientific discipline and its organization, that is, the (semantic) relations that exist between these objects. Hence, so far, Cog-Con and Quine's frameworks seem to be in good agreement concerning issues of ontology and language.

However, as previously seen, Quine's epistemological framework leads him to ascertain the *indifference or inscrutability of ontology*. This indifference, in turn, takes him to a strict observation/ prediction/ verificationalist position, that gives little room for more important roles to be played by ontology or metaphysics. In Quine (1992, p.31), see also Gibson (2004, p.137-138), he states:

> *Reference and ontology recede thus to the status of mere auxiliaries. True sentences, observational and theoretical, are the alpha and omega of the scientific enterprise.*

In Quine (1969, p.80), he goes to the extreme of saying of the Vienna Circle that they – *espoused a verification theory of meaning but did not take it seriously enough*, see also Gibson (2004, p.226). Ironically, this takes Quine to embrace an extreme form of Positivism concerning the role of metaphysics, in perfect syntony with the ideas of Auguste Comte, founder of the Positivist movement, as seen in the following quotations.

> *Now it is an ironical but familiar fact that though the business of science is describable in unscientific language as the discovery of cause, the notion of cause itself has no firm place in science. The disappearance of causal terminology from the jargon of one branch of science and another has seemed to mark the progress in understanding of the branches concerned.* Quine (1966, p.242), as quoted in Hylton (2010, p.358).

> *The first characteristic of the Positive Philosophy is that it regards all phenomena as subjected to invariable natural Laws. Our business is – seeing how vain is any research into what are called Causes, whether first or final, – to pursue an accurate discovery of these Laws, with a view to reducing them to the smallest possible number. By speculating upon causes, we could solve no difficulty about origin and purpose. Our real business is to analyze accurately the circumstances of phenomena, and to connect them by the natural relations of succession and resemblance*. Comte (1858, p.27), quoted in Gibson (2004, p.220).

In contrast, from the Cog-Con epistemological framework's perspective, ontology and metaphysics are at the center stage of the scientific scenario, and play a pre-eminent role in good epistemological analysis.

From the Cog-Con perspective, Metaphysics concerns causal explanations telling why things are the way they do. These are the narratives and metaphors, often intertwined with abstracts symbolic statements, we use to build our understanding, to gain insight or intuition about objects in our world and the way they work. Hence, good scientific ontologies, even if informally defined, are an indispensable tool for metaphysical and theoretical reasoning and both, ontology and metaphysics, are necessary supports for the conception, development, implementation and consistent application of experimental procedures and operational means and methods. As such, ontology and metaphysics are of paramount importance in scientific life, taking part in all steps of the production diagram depicted at Figure 1.

From the Cog-Con perspective, the clarity of understanding, insight, or intuition provided to its end users by a good ontology, and its associated metaphysical (causal) explanations, must be carefully and thoroughly considered. Such considerations may even justify the non-trivial concomitant use of alternative but formally equivalent ontologies and theoretical frameworks. Indeed, let us consider the case of two or more of such formally equivalent frameworks like, for example, Newtonian,

Lagrangean and Hamiltonian classical mechanics, or the standard and Feynman's path integral formulation of quantum mechanics. From the Cog-Con perspective, even if two such frameworks are formally equivalent, their different ontological commitments and characteristic causal relations are still very relevant in the active practice of science and, therefore, from a Cog-Con perspective, equally important for epistemology.

For a detailed discussion of the Cog-Con perspective, including similar ideas of Max Born, and further contrasts with Positivism's strict observation/ prediction/ verificationalist position, see Stern (2008b,Ch.4; 2011a,b), Stern and Pereira (2014) and Born (1956). Max Planck (1950, p.171-172) presents a comparable position:

> *Positivism lacks the driving force for serving as a leader on this road. True, it is able to eliminate obstacles, but it cannot turn them into a productive factors. For its activity is essentially critical, its glace is directed backward. But progress, advancement requires new associations of ideas and new queries, not based on the results of measurements alone, but going beyond them, and toward such things the fundamental attitude of Positivism is one of aloofness.*

5.7 Future Research Final Remarks

Self-Identities at Neurath's Ship

As a wordy epistemological framework, Cog-Con should be useful for statical analysis of a scientific discipline, that is, it should be a helpful device for making sense of the daily activities of the system as it operates in a given status quo. However, the Cog-Con framework also aims at dynamical analyses, aspiring to provide useful tools for understanding science in its development and evolution. We believe that Cog-Con can offer valuable insights at the never-ending processes of re-construction while staying afloat that characterizes Neurath's Ship. In particular, we believe that the Cog-Con approach can provide intuitive guidelines for engineering and using computational tools for *ontology alignment*, see Stern (2014). Synchronic and diachronic ontology alignments, in turn, can help us to understand the underlying continuities of systems in their development and evolution, that is, can help us to understand the safe-guarding of self-identities during the brave voyages of Neurath's Ship.

Handling Sticky Things

> *Truth, meaning and belief are sticky concepts. They stick together.... Meaning and belief ... can be separated, like Siamese twins, only by artificial means... But it is the remaining pair, truth and belief, that seems to me to have got unobservedly stuck.*

These are among the opening statements of *On the very Idea of a Third Dogma*, Quine (1981a, p.38). The objective of the present article was to make a high contrast

and minimalist comparison between Cog-Con and Quine's epistemological frameworks. Future research should enrich this bare-bone and schematic comparison with finer points and higher resolution details. Contrasting appropriate concepts of truth, meaning and belief in Cog-Con, Quine and also Davidson's epistemological frameworks should be part of this effort. Sticky as they are, a comparative study of these three concepts will eventually involve a related triad of sticky things, namely, the concepts of objectivity, subjectivity and inter-subjectivity. Furthermore, this line of research requires discussing the roles played in naturalized epistemologies by Ontology and Metaphysics in greater depth than we could afford at the present article.

Handling Uncertainties in Circular Ontologies

A self-defined mission of CODATA, the International Committee on Data for Science and Technology, is – *to periodically provide the scientific and technological communities with a self-consistent set of internationally recommended values of the basic constants and conversion factors of physics and chemistry based on all of the relevant data available at a given point in time*. For more on the importance and meaning of universal constants, these *immutable building blocks blocks of the edifice of theoretical physics*, see Planck (1950, p.170-172).

Many international laboratories are involved in this on-going effort to obtain ever more precise values for universal constants, using a variety of alternative experimental methods. However, each value obtained for one of these fundamental constants is a (non-linear) function of the value of several others constants. Such a project creates a large database where entities are circularly defined, a situation that can be handled using methods based on Aczel's Hypersets and its derivatives. Furthermore, the reliability of each one of these experiments, the quality and conditions of its implementation, and a variety of other influencing factors must also be accounted for. This creates a second-order effect of circular propagation of uncertainties.

A simple approach to quantify uncertainties about universal constants could be based on the (convergent, circular) propagation of variances and covariances, the second-order statistical moments. Borges and Stern (2007) and Stern (2004) suggest possible ways to handle empirical hypotheses and to treat more complex relations.

We are interested in extensions of already existing computational tools, like Pakkan and Akman (1995) and Iordanov (2010), aiming at the easy handling of sets of circular uncertainties. Such computational tools could, in turn, be used in the effort of evaluating scientific ontologies and constructing or justifying synchronic and diachronic ontology alignments, see Stern (2014).

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