

# Programme of the Seventh Young Researchers Days in Logic, Philosophy and History of Science

23-24 September 2021

Online Event

URL=<<http://bslps.be/YRD7/>>

## Thursday 23 September

### 8.55 a.m.

Opening words

### 9-10 a.m.

Chair: Jip van Besouw (VUB)

**Gwenaël Laurent** (UCL), *Can a Transfinite Turing Machine solve 3-SAT<sub>N<sub>0</sub></sub> in a Cantor Space?*

**Pierre Saint-Germier** (UCL), *Hyperintensionality, Opacity, and Counterpossibles*

### 10-11 a.m.

Keynote lecture

Chair: Steffen Ducheyne (VUB)

**Hanne Andersen** (Department of Science Education, University of Copenhagen), *The History and Philosophy of Scientific Misconduct*

### 11-11.15 a.m.

Coffee break

### 11.15 a.m.-12.45 p.m.

Chair: Peter Verdée (UCL)

**Jeremy Attard** (UMons), *Toward a Unitary Epistemological Criterium for Empirical Knowledge*

**Kristine Grigoryan** (KULeuven), *Berkeley and Kant on the Limits of Knowledge and Science: A Historical, Conceptual and Logical Investigation*

**Antione Brandelet** (UMons), *Model-Based Reasoning, Scientific Representation and Fiction*

### 12.45-1.30 p.m.

Lunch break

### 1.30-3 p.m.

Chair: Steven Vanden Broecke (UGent)

**Valentine Delrue** (UGent–Università Ca' Foscari Venezia), *Corrupter of Bodies? An Analysis of the Verhandelingen of the Batavian Society of Arts and Sciences (1778-1794) on Managing the Health of the Citizens of Batavia*

**Andrew A.M. Morris** (VUB), *Smeaton's Early Research on Electricity*

**Hein Brookhuis** (KULeuven), *The Making of a European Reactor in Belgium: Competition and Cooperation in Big Science (1990–2010)*

### 3-3.15 p.m.

Coffee break

### 3.15-4.15 p.m.

Keynote Lecture

Chair: Peter Verdée (UCL)

**Gillian Russell** (Dianoia Institute of Philosophy, Australian Catholic University), *How to Prove Hume's Law*

**04.15-05.15 p.m.**

Chair: Jan Heylen (KULeuven)

**João Daniel Dantas de Oliveira** (UCL), *Some Thoughts on Tonk*

**María Terrés Villalonga** (UCL), *Two Routes to Relevance*

## Friday 24 September

**9-10 a.m.**

Chair: Peter Verdée (UCL)

**Leander Vignero** (KULeuven), *Morphisms of Aristotelian Diagrams*

**Stef Frijters** (KULeuven), *Generalizing Aristotelian Relations to Sets of Formulas*

**10-11 a.m.**

Keynote lecture

Chair: Steven Vanden Broecke (UGent)

**Sara Miglietti** (The Warburg Institute, London), *Governing (through) the Environment: 'Mesopolitics' in Early Modern Europe*

**11-11.15 a.m.**

Coffee break

**11.15 a.m.-12.45 p.m.**

Chair: Steffen Ducheyne (VUB)

**Massimiliano Simons** (UGent), *What is the History of Philosophy of Experimentation a History of?*

**Jan Potters** (UAntwerp), *Opening up HPS-Debates: On Reading Kuhn and the History of the Quantum*

**Sacha Ferrari** (KULeuven), *An Agent-Based Interpretation of the Doctrinal Paradox*

**12.45-1.30 p.m.**

Lunch break

**1.30-3 p.m.**

Chair: Jo Coture (UGent)

**Frederik Dhondt** (VUB), *The Genesis of the Queries in Isaac Newton's Opticks/Optice: The Role of Allegiances and Rivalries*

**C.J. Schilt** (VUB), *When Worlds Collide: Isaac Newton and the Study of Chronology*

**Thijs De Coninck** (UGent), *Original Position Arguments and Social Choice under Ignorance*

**3-3.15 p.m.**

Coffee break

**3.15-4.15 p.m.**

Chair: Jip van Besouw (VUB)

**Kévin Chalas** (UCL), *A Pointless Solution for Zeno's Paradox of the Arrow*

**Astrid Modera** (UNamur), *Can Relations have Ontological Primacy?*

## Contributed Papers (alphabetically by author)

### Toward a Unitary Epistemological Criterium for Empirical Knowledge

Jeremy Attard

Université de Mons, Faculté des Sciences, Service d'Histoire et Philosophie des Sciences

A certain number of epistemological criteria are usually acknowledged to be relevant in order to recognize genuine empirical knowledge. They are quite different depending on the field under study and usually not thought in a unitary way. For instance, Karl Popper's methodological falsificationism (cf. [5], [2]) is sometimes thought as being efficient in fields like physics, whereas another notion of scientificity should apply to sciences the object of which is historical, like sociology (cf. [4]) or evolutionary biology (cf. [3].)

In this paper, against this dualist vision of science, I aim to define (empirical) scientific knowledge independently of a particular object of study. This definition takes the form of a general epistemological principle, i.e. a normative requirement applying to anything claiming to be scientific empirical knowledge. The elaboration of such a general principle is based on three fundamental distinctions: 1) discovery/justification context; 2) theoretical/empirical axioms; 3) analytic/synthetic statements.

I place my work in the context of justification, aiming to elaborate a normative criterium applying to conceptual corpus independently of their development history. Conceptual issues could appear about the two next distinctions (cf. [7], [6], [1].) Yet, their relevance depends on the scale at which a given theory is studied. In my work, I place myself at the scale of a model. At such a scale, by definition, the distinction between theoretical and empirical axioms can be made clear. Moreover, this model's viewpoint allows to work as if the empirical part of a model and its explanatory part could be safely separated – and I focus here on the empirical part.

This allows to define scientific empirical knowledge merely as having to be made, at this scale, of empirical synthetic statements. I claim that this general principle: 1) is independent of the nature of the object under study; 2) allows to recover well-known empirical criteria once actualised within different research fields.

Examples will be taken from various fields. Further considerations about epistemological criteria applying to explanations are sketched in the conclusion.

#### References

- [1] T. Kuhn. *The Structure of Scientific Revolutions*. ISSR collection. University of Chicago Press, 1996.
- [2] I. Lakatos. *The Methodology of Scientific Research Programmes: Philosophical Papers, Volume 1*. Cambridge University Press, 1978.
- [3] Ernst Mayr. *Darwin's Impact on Modern Thought. Proceedings of the American Philosophical Society*, 139(4): 317-325, 1995.
- [4] J.C. Passeron. *Le raisonnement sociologique. L'espace non-poppérien du raisonnement naturel*. Paris, Nathan, 1991.
- [5] K. Popper. *The Logic of Scientific Discovery*. Julius Springer. Hutchinson and Co., 1959.
- [6] W. V. Quine. On Empirically Equivalent Systems of the World. *Erkenntnis* (1975), 9(3): 313-328, 1975.
- [7] Willard Quine. *Two Dogmas of Empiricism*, pages 41-64. Springer Netherlands, 1976.

### Model-Based Reasoning, Scientific Representation and Fiction

Antoine Brandelet

Université de Mons, Faculté des Sciences, Service d'Histoire et Philosophie des Sciences

In recent years, the question of scientific representation has attracted the attention of many philosophers and has been much discussed (see for example the collection of articles edited by Mauricio Suárez (*Fictions in Science: Philosophical Essays on Modeling and Idealization*, Routledge, 2009)). Many conceptions oppose each other on different points of analysis, but the problematic is generally structured around the notion of model and its relation with scientific theories. The central question is therefore: what makes a scientific model represent the system under study?

Among the conceptions defended, one is based on a similarity between model-based reasoning and works of fiction [Frigg and Nguyen 2016]. This fictional view of models bases its analysis on Walton's concept of make-believe [Toon 2012]. According to its advocates, the scientist's attitude when using a model to represent a physical system is the same as when we are faced with a work of fiction: we pretend to believe what is told to us, even if we know that approximations, idealizations or fictions are integrated into the model. This conception therefore raises questions both about the explanatory capacity of models and about their ontological interpretation.

In this presentation, I will first show how the fictional conception of models allows us to answer some general problems of scientific representation. In particular, I will focus on the importance of taking into account the possibility of misrepresentation in an account of scientific representation and on the problems that this poses to purely structural conceptions of models.

Secondly, I will address the case of realism. If scientific realism states that science aims at truth, the fictional account I defend seems at first sight to promote anti-realism. I will show that this is not the case and that a realistic conception of scientific theories can accommodate the problem of misrepresentation.

## References

- Frigg, Roman and James Nguyen (2016). "The Fiction View of Models Reloaded". *The Monist* 99.3, pp. 225–242.
- Toon, Adam (2012). *Models as Make-Believe*. Palgrave Macmillan.

## **The Making of a European Reactor in Belgium: Competition and Cooperation in Big Science (1990–2010)**

Hein Brookhuis

KU Leuven, Research Group Cultural History since 1750

Since 1995, the Belgian Nuclear Research Centre (SCK CEN) has been involved in the creation of a new nuclear research reactor in Mol. In 2010, the scientists managed to have their reactor – named MYRRHA – recognized as a priority on the list of the European Strategy Forum on Research Infrastructures. This type of initiatives has been described by historians as Big Science, being prestigious national scientific initiatives that occupy a unique place in the post-war scientific landscape. This paper aims to contribute to our understanding of contemporary Big Science by focusing on recent European initiatives to formalize the set-up of such research facilities.

A recent study has identified Big Science collaborations in Europe as 'The Other Europe,' a form of integration that developed in parallel to the European Economic Community, but which was not formally connected to it. From the 1980s onwards, however, science became increasingly recognized as a strategic goal of the EEC, and led to the introduction of formalized policies. Based on primary sources, this paper shows what role these policies played in the development of an initially small-scale Belgian reactor project to a large-scale European priority. In doing so, it will analyse how MYRRHA was shaped by competition and collaboration with other scientists through formal and informal networks in Europe.

More broadly, this paper aims to contribute to the growing historiographical literature on 'New Big Science', which addresses the ongoing transformation of Big Science research facilities and their position in current science policy. By analysing the organization of MYRRHA, this paper aims to enhance our view on the legitimization and coordination of Big Science in the recent history of science policy.

## **A Pointless Solution for Zeno's Paradox of the Arrow**

Kévin Chalas

Université Catholique de Louvain, CEFISES, Institut Supérieur de Philosophie

If one follows Russell's hegemonic cinematographic account of change, it is nothing more than, for an entity, to have different properties at different times; i.e. a temporally ordered sequence of intrinsically static states of an entity. The success of this picture is easily explained as it allows one to have a resolution of Zeno's paradoxes that fits their mathematical resolution through set theory, its concepts of limits and continuum, and the modelling of time by the real line (Grünbaum 1952, 1968). Analytic differential geometry being the basis of classical physics, Russell's proposition carries over nicely into its ontology. Is change then necessarily reduced to the cinematographic picture in any ontology of physics?

It would be in as far as as nothing is dynamic here: two states in the sequence don't overlap, the real line and the manifold of the models remaining separable, and instantaneous velocity, which should explain the transition between states, makes sense only as an abstraction of mean velocity. I claim however that the cinematographic picture is contingent, since it relies on the set theoretical notion of continuum and the use of analytic methods in mathematical physics. In fact, the rigorous development of Synthetic Differential Geometry, backed by the tools of category theory, gives us a new way to build mathematical models for spacetimes where the concept of continuum is a primitive non-reducible to points and Zeno's paradoxes do not hold. The possibility of reconstructing Einstein's equations under this formalism, despite the necessity to use intuitionist logic, gives weight to the probability for such a method to be equivalent to the usual one (even if no formal proof of physical equivalence has been given yet). This gives a basis to defend the non-necessity of Russell's picture and the compatibility with "true change" for the ontology of any classical physical theory.

## **Some Thoughts on Tonk**

João Daniel Dantas de Oliveira

Université Catholique de Louvain, SSH/ISP, Institut supérieur de philosophie

A. Prior proposed the connective tonk as an objection to the doctrine to which the logical connectives' meaning is given by their logical rules in a proof system. This connective mixes the introduction of disjunction with the elimination of conjunction as its logical rules. According to the previous doctrine, the connective tonk is meaningful, but adding this connective to a logical language might trivialize the logic. There have been several attempts to solve the problem by refining the original philosophical doctrine. One such attempt is due to M. Dummett. We identify that at the core of Dummett's solution to the tonk problem lies the idea that our linguistic practices are open to criticism. Dummett proposed the distinction between the theory of meaning and a meaning-theory. The first one he reserves to be another name for the philosophy of language and the second he uses to designate a complete specification of the meaning of each expression belonging to a particular language. According to Dummett, the goal of the philosophy of language (the theory of meaning in his terminology) is to find universal principles, about the concept of meaning, upon which a formal meaning-theory can be construed. One of these principles is the harmony principle. Dummett's solution thus is to identify tonk as a particular case of failure of harmony. If there are ways of formalizing the principle of harmony on a logic level, for Dummett it is possible to prohibit the construction of a tonk-like connective. We explore an alternative Carnapian solution that diverges fundamentally with the idea that there are normative claims made about logical languages. Based on Carnap's Principle of Tolerance, it is not the logician's job to set up prohibitions upon logical systems. From this point of view, a logic that is tonk-admissible is neither "good" nor "bad", even though it might be the case that this logic lacks many formal properties that other logics might have.

## **Original Position Arguments and Social Choice under Ignorance**

Thijs De Coninck  
Ghent University, Centre for Logic and Philosophy of Science

John Rawls famously argued that the Difference Principle would be chosen by any rational agent in the original position. Derek Parfit and Philippe Van Parijs have claimed, contra Rawls, that it is not the Difference Principle which is implied by Rawls' original position argument, but rather the more refined Lexical Difference Principle.

In this paper, we study both principles in the context of social choice under ignorance. First, we present a general format for evaluating original position arguments in this context. We argue that in this format, the Difference Principle can be specified in three conceptually distinct ways. We show that these three specifications give the same choice recommendations, and can be grounded in an original position argument in combination with the well-known maximin rule. Analogously, we argue that one can give at least four plausible specifications of the Lexical Difference Principle, which however turn out to give different recommendations in concrete choice scenarios. We prove that only one of these four specifications can be grounded in an original position argument. Moreover, this one specification seems the least appealing from the viewpoint of distributive justice. This insight points towards a general weakness of original position arguments.

### **Corrupter of Bodies? An Analysis of the *Verhandelingen* of the Batavian Society of Arts and Sciences (1778-1794) on Managing the Health of the Citizens of Batavia**

Valentine Delrue  
Ghent University – Ca' Foscari Venezia

During the early modern period, fears about the impact of the environment on the body incited colonial settlers to adopt strategies to prevent disease by managing their surroundings. This paper will investigate these practices in Dutch Batavia. The Batavian Society of Arts and Sciences, which was founded in 1778, published six volumes of *Verhandelingen* (*Treatises*) from 1779 until 1794. These *Verhandelingen* contain contributions on how to improve the dire health of the population in Batavia by relying on solutions such as cleaning out canals, ventilating homes, and keeping to a moderate diet. Interestingly, the advice in the *Verhandelingen* contrasts with earlier reports written in the context of government investigations that focused on large-scale interventions in the environment such as draining swamps and deviating rivers.

How can this shift in therapeutics from large-scale interventions in the environment to smaller-scale ones based on the non-naturals be explained? I will argue that the members of the Batavian Society directed their efforts toward a scale they deemed manageable. By focusing on new measures, they could keep up a health discourse that sustained the colonial project. First, I will look at the impasses the settlers faced with the great-scale interventions and their pessimism about "fighting nature". Second, I will investigate how the different professional backgrounds and skills of the members of the Batavian Society converged in an interdisciplinary "medicine of the environment" that brought new health solutions.

### **The Genesis of the Queries in Isaac Newton's *Opticks/Optice*: The Role of Allegiances and Rivalries**

Frederik Dhondt  
Vrije Universiteit Brussel, Centre for Logic and Philosophy of Science

Isaac Newton's *magna opera*, the *Principia* and the *Opticks*, gathered considerable attention upon their first and subsequent appearances. Reactions to the works were varied, seemingly creating "factions" of supporters and opponents. Many of the ensuing conflicts and their effects on contemporaneous debates, for example the Leibniz-Clarke correspondence, have already been extensively recorded and discussed. An episode that has received much less scholarly attention is the genesis of the Queries to the English

*Opticks* and the Latin *Optice* in the years 1704-1717. Although the Queries have garnered ample attention ever since their first appearance, their development throughout the different versions of the *Opticks* (1704, 1717, 1721, and 1730) and the *Optice* (1706 and 1719) has been less thoroughly scrutinized. In this presentation, I analyse different drafts of both the *Optice* (1706) and the *Opticks* (1717) in search of the alliances and rivalries that inspired Newton to write his Queries. More specifically, I focus on those Queries that contain theology and/or methodology.

With regards to the *alliances*, I consider Samuel Clarke's involvement in, and intellectual contributions to, the publication of the *Optice*. After the initial publication of the *Opticks* (1704) in English, Newton planned to publish a Latin version that was to be translated by Clarke. Additionally, Newton added seven Queries to that version, concerned with subjects such as theology, methodology, chemistry etc. Beyond his work of translation, commentators are unclear about the extent to which Clarke contributed to those new Queries. By looking at the draft material to the *Optice*, I argue that previously unnoticed marginal notes in Clarke's hand indicate that he was intellectually invested in the process of writing and editing some the Queries.

This draft material, as well as that prepared for the 1717 edition, also attests to Newton's urge to react to his *adversaries* in writing. Even though he softened or redirected many of his responses in the published versions, they are often still present in a latent form. This allows one to retrace the development of many of the famous Queries and identify Newton's inspiration for them.

### **An Agent-Based Interpretation of the Doctrinal Paradox**

Sacha Ferrari

KULeuven, Centre for Logic and Philosophy of Science

This paper proposes a new interpretation of the doctrinal paradox by considering an agent-based decision process instead of a majority voting one. Our aim is to investigate how often the doctrinal paradox occurs in an interacting community. This paradox occurs when the final sentence of a deliberating process is in contradiction with its two premises. The implemented model we chose is a multivariate improvement of the Hegselmann-Krause opinion dynamic model [1]. We considered that each individual averages his/her prior opinion with those of the other agents' if these agents are located within his/her bound of confidence. We simulated millions of random initial communities and let them evolve. At the end of the interaction process, we assessed how many of them led to an opinion configuration in which the doctrinal paradox is present. Consequently, a quantitative comparison between majority-voting and agent-based generated final sentences has been performed. Two surprising results emerged. First, in at least 92% of the cases, the two procedures end up with exactly the same decision. Secondly, the latter is irrational a quarter of the time (on average) in both models. Which means that the doctrinal paradox occurs regardless of the presence of interaction between agents.

To make our model even more realistic, we considered our agents as confirmation biased: if two agents A and B are in conflict concerning belief  $p$ , the more A has beliefs in common with B, the more A will be prone to take into account B's opinion concerning  $p$ . By considering this confirmation bias in our model, for a large number of agents, majority voting leads to 7% fewer irrational decisions than an agent-based model. These results raise some moral issues about the usefulness of public debate in decision making.

#### **References**

[1] Hegselmann, R., Krause, U. (2002). Opinion dynamics and bounded confidence models, analysis, and simulation. *Journal of artificial societies and social simulation* 5(3).

### **Generalizing Aristotelian Relations to Sets of Formulas**

Stef Frijters

KULeuven, Centre for Logic and Philosophy of Science

The famous Aristotelian square of opposition gives rise to four Aristotelian relations: contradiction (CD), contrariety (C), subcontrariety (SC), and subalternation (SA). The study of these relations has a long history in philosophical logic. Recently, the square and the four relations have been noted for their informativity, and have found applications in fields as diverse as computer science, cognitive science and linguistics.

The four Aristotelian relations have traditionally been defined as relations between two formulas. In this talk, I will show that these relations can be generalized to relations between non-empty sets of formulas. I show that this generalization can be defined in such a way that the relations between the Aristotelian relations are preserved. For example, for the traditional relations the following holds. Given a suitable logic  $\mathbf{S}$  and language  $\mathbf{L}$  of  $\mathbf{S}$ , for any formulas  $\varphi, \psi, \chi \in \mathbf{L}$  such that  $\varphi$  is CD to  $\psi$ :

$$\chi \text{ and } \psi \text{ are in SA iff } \chi \text{ and } \varphi \text{ are C.}$$

A similar relation holds for the generalized relations CD', C', and SA'. For any sets of formulas  $\Gamma, \Delta, \Theta \subseteq \mathbf{L}$  such that  $\Gamma$  is CD' to  $\Delta$ :

$$\Theta \text{ and } \Delta \text{ are in SA' iff } \Theta \text{ and } \Gamma \text{ are C' .}$$

This generalized definition of the four Aristotelian relations gives rise to new geometric figures, including a new square of opposition. These differ from the traditional figures in that they have sets of formulas instead of individual formulas at the corners.

I will end the talk by showing that there are multiple possible generalizations, some of which also preserve the relations between the Aristotelian relations. These different generalizations capture different intuitive understandings of the traditional Aristotelian relations. I will discuss how this fact can affect our understanding of the traditional relations.

## **Berkeley and Kant on the Limits of Knowledge and Science: A Historical, Conceptual and Logical Investigation**

Kristine Grigoryan

KULeuven, Centre for Logic and Philosophy of Science

This paper discusses the limits of knowledge and science according to the anti-realist theories of knowledge of Berkeley and Kant while taking into account contemporary insights from discussions about epistemic paradoxes. I first analyse and compare their anti-realist positions. After reaching an understanding of their positions, I discuss how knowledge and science are possible and what kind of truth theories are accepted by Berkeley and Kant. This allows us to move forward and understand whether they accept that all truths are knowable. After discussing Berkeley's and Kant's accounts of knowability, I briefly touch on the knowability paradox known as the Fitch paradox, which inevitably arises in the scope of antirealism. Fitch has already shown that the knowability thesis, which involves a non-factive notion of knowability, faces omniscience by stating that if every truth is knowable, then every truth is known. I aim to analyse Berkeley's and Kant's approaches and see whether they avoid or accept this undesirable conclusion.

The paper proceeds as follows. Section I focuses on Berkeley's subjective idealism and describes Berkeley's reasoning. By discussing Berkeley's theory of knowledge, particularly his truth theory, and by reconstructing his knowability approach, I finally formulate his knowability concept, showing that Berkeley accepts factive knowability according to which only truths are perceivable. Even though factive knowability could avoid human omniscience, Berkeley leaves us with some ambiguities regarding this topic. In the case of one of the possible interpretations of his text, human knowability collapses human knowledge. Section II explores Kant's transcendental idealism, Kant's understanding of scientific knowledge and truth, and eventually the knowability concept, according to which all empirical truths are knowable. I also discuss Kant's approach to human omniscience, showing that we inevitably face human omniscience using Fitch-style reasoning, while Kant never openly claims it. Moreover, adopting the concept of the extension of the content of empirical knowledge, he leaves room

for the existence of unknown empirical truths to be known in the future. Finally, section III contrasts the results of the first two sections by highlighting the similarities and differences between Berkeley's and Kant's positions on the limits of knowledge and science.

### **Can a Transfinite Turing Machine solve 3-SAT $\aleph_0$ in a Cantor Space?**

Gwenaël Laurent

Université Catholique de Louvain, Institut Supérieur de Philosophie

Let 3-SAT $\aleph_0$  be the problem obtained by adding to 3-SAT a countable infinite number of clauses and variables. Any solution of this problem can be expressed in a cantor space  $\{0, 1\}^{\aleph_0}$ . Checking if  $s \in \{0, 1\}^{\aleph_0}$  is a solution can be done in  $\aleph_0$  steps, but finding one by brute force takes  $\aleph_1$  iterations in almost all cases. The question addressed by this paper is the following: is there an implication between  $P = NP$  conjecture and the problem of solving 3-SAT $\aleph_0$  in a countable time?

First, a  $\mathbf{T}_{\omega_1}$  transfinite extension of Turing machine will be introduced. When executed for a finite time,  $\mathbf{T}_{\omega_1}$  and a classical Turing machine are indistinguishable. But when the number of steps reaches  $\omega_0$ , complex discrepancies can appear. Unlike Turing machines with Oracle,  $\mathbf{T}_{\omega_1}$  is provided with an explicit description. Moreover, the definition of  $\mathbf{T}_{\omega_1}$  leads to a generalization of Rice's theorem that specifies what kind of implications exist between finite and infinite machines. It will be shown that some questions concerning their mutual relationships cannot be solved, including most  $P = NP$  conjecture relevant questions.

In the second part, a time countable algorithm for 3-SAT $\aleph_0$  will be provided. In this purpose, a geometric representation of the problem will be put forward, where the domain of admissible solutions can be assimilated to the line segment  $[0, 1]$ . The clauses themselves will be expressed by means of periodic functions cancelling out on certain key values of  $[0, 1]$ .

In conclusion, the present paper intends to take five contributions: (1) introducing a new tool in hypercomputation theory, (2) showing that 3-SAT $\aleph_0$  is soluble in a countable number of steps, (3) providing a geometric representation of 3-SAT, (4) discussing some new strategical ideas concerning  $P = NP$  conjecture and (5) concluding with an informal and open-to-debate philosophical argument about the deductive power of a transfinite Turing Machine compared to human mind.

### **Can Relations have Ontological Primacy?**

Astrid Modera

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In this presentation, I discuss the ontological importance given to relations. I will explore two ways of thinking a relational ontology. The first one is developed in non-standard approaches of emergence, in works of philosophers such as Humphreys (2016) and Santos (2020). In those approaches, relational ontology is understood in a way that relational processes are qualitatively transformative (Santos 2015). Relations thus have ontological power to transform relata. Nonetheless, Santos (2015) argues that it makes no sense to give ontological priority to one of the two ontological categories, relations and relata. They are mutually defining and imply each other.

But the second approach I am interested in might lead to another direction. In relational biology (Rashevsky 1954 & 1961, Rosen 1958 & 1991), the importance given to relations is firstly epistemological. Relational biology aims to create a mathematical model for living systems and, in that purpose, it focuses on the internal organization of such systems. The theory of categories, the mathematical tool used in relational biology (Rosen 1958), contains the possibility of giving primacy to relations over objects, thanks to, for example, the identity morphism. Even though Rosen and relational biologists stay on an epistemological level when they say "throw away the matter and keep the underlying organization" (Rosen 1991), I suggest considering this stance on an ontological level. In that sense, relations might ontologically prevail over relata.

I will question the distinction between those two positions and place them among other relational ontologies, Nietzschean and Heraclitean especially (Carli 2016). I will also compare them to non-substantialist ontologies as those that can be found in Ruyer's (1930) and Simondon's (1964) works.

### References

- CARLI, R., "Relational Ontology in Nietzsche: An Introduction", *Parrhesia*, n°26 (2016), 96-116.  
HUMPHREYS, P., *Emergence. A Philosophical Account*, Oxford: Oxford University Press, 2016.  
RASHEVSKY, N., "Topology and Life: In Search of General Mathematical Principles in Biology and Society", *Bulletin of Mathematical Biophysics*, vol. 16 (1954), pp. 317-348.  
RASHEVSKY, N., "Abstract Mathematical Molecular Biology" in *Bulletin of Mathematical Biophysics*, vol. 23 (1961), pp. 237-260.  
ROSEN, R., "The Representation of Biological Systems from the Standpoint of the Theory of Categories", *Bulletin of Mathematical Biophysics*, vol. 20 (1958), pp. 317-341.  
ROSEN, R., *Life Itself. A Comprehensive Inquiry Into The Nature, Origin, And Fabrication Of Life*, New York, Columbia University Press, 1991.  
RUYER, R., *Esquisse d'une philosophie de la structure*, Paris, Librairie Félix Alcan, 1930.  
SANTOS, G. C., "Ontological Emergence: How is that possible? Towards a new Relational Ontology", *Foundations of Science*, 20 (2015), pp. 429-446.  
SANTOS, G. C., "Integrated-structure emergence and its mechanistic explanation", *Synthese* (2020).  
SIMONDON, G., *L'individuation à la lumière des notions de forme et d'information*, Paris, PUF, 1964.

### Smeaton's Early Research on Electricity

Andrew A.M. Morris

Vrije Universiteit Brussel, Centre for Logic and Philosophy of Science

In this talk, I would like to provide an overview of eighteenth-century English engineer John Smeaton's early research on electricity. Although he is most well-known for his career as a civil engineer, Smeaton first trained as a scientific instrument maker. He made improvements to Hauksbee's air pump and designed a friction machine used by his childhood friend Benjamin Wilson (1721-1788)— a painter and electrical experimenter. Smeaton's first scholarly publication was a short article on some experiments on the velocity of electricity that he carried out with Wilson, and that appeared in an issue of the *Gentleman's Magazine* of 1747. In this paper, we already find evidence of Smeaton's method of parameter variation that came to characterize his later research. Following this, electrical experiments carried out by Smeaton are mentioned in Wilson's *Treatise on Electricity* (1750). In a paper from 1752, William Watson (1715-1787), another leading electrical experimenter of the period, thanked Smeaton for making the experimental apparatus he required, which was built around Smeaton's improved air pump. Of particular interest from a methodological standpoint are some experiments of Watson's on electricity in a vacuum – using Smeaton's own air pump – that Smeaton subsequently repeated. According to Joseph Priestley (1733-1804), Smeaton's set of experiments were "in several respects, similar to those made by Dr. Watson, and yet are attended with a considerable variety of circumstances." I will focus on whether this was because Smeaton's more open-ended method of parameter variation differed from that of his contemporaries.

### Opening up HPS-Debates: On Reading Kuhn and the History of the Quantum

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Since a few decades, historical studies of the early quantum have taken a meta-historical turn: they are interested not only in how Planck saw the discrete energy elements he introduced, but also in how to study this question historically. This is a consequence of Thomas Kuhn's work on the quantum, in which he argues, against the standard view of Planck as the first to introduce the quantum, that Planck, for a long time, understood his work in classical, continuous terms.

In this talk, I will argue that most meta-historical responses to Kuhn's book read it with a theory-driven understanding of paradigms in mind, and that Kuhn's book should actually be read in practice-focused terms. Such a practice-focused reading comes down to the claim that Planck's early work on black bodies should not be read as a theory, but rather as a collection of techniques, borrowed from Ludwig Boltzmann and transformed to suit the problem at hand. One advantage of this reading is that we do not need to ascribe to Planck any substantially worked out stance, either classical or quantum, with regards to the question of how he saw energy.

On the basis of this, I will then argue that the meta-historical debate focuses too much on the relation with Kuhn's work on *The Structure of Scientific Revolutions*, and too little on the work that Kuhn carried out after *Structure*, and before he started his book on Planck, primarily the interviews he conducted with physicists for the *Archive for the History of Quantum Physics*. This will suggest that after *Structure*, and partially because of his engagement with oral history, Kuhn came to understand paradigms more and more in practice-focused terms.

### Hyperintensionality, Opacity, and Counterpossibles

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Can counterpossibles be false? The Orthodox doctrine of Vacuism is that all counterpossibles are vacuously true [Stalnaker, 1968, Lewis, 1973, Williamson, 2017]. However a number of Reformists defend the contradictory view, i.e. Nonvacuism, that some counterpossibles, at least, are best regarded as false rather than vacuously true [Brogaard and Salerno, 2013, Berto et al., 2017]. One reason to remain with the Orthodoxy [Williamson, 2017] is that Nonvacuism fails to account for the objectivity of counterfactuals. The argument can be reconstructed as follows:

1. Counterfactuals, in general, express a non epistemic relation between the antecedent and the consequent.
2. If Nonvacuism is true, then counterpossibles are referentially opaque.
3. If counterpossibles are referentially opaque, they express an epistemic relation between the antecedent and the consequent.
4. Therefore Nonvacuism is false.

Some Reformists are happy to accept that counterpossibles are epistemic, unlike non-counterpossible counterfactuals, and reject 1 [Brogaard and Salerno, 2013]. Others claim that they can provide simultaneously non epistemic and referentially opaque counterpossibles Berto et al. [2017], and thus reject 3. The Orthodox [Williamson, 2017, e.g.] can then retort that both moves end up giving counterfactuals an implausibly hybrid logic, where some substitution principles hold only for possible antecedents, but not for impossible ones. For example, one would have

$$(1) a = b, \diamond A, A \Box \rightarrow B \vdash A \Box \rightarrow B [a/b]$$

but

$$(2) a = b, A \Box \rightarrow B \not\vdash A \Box \rightarrow B [a/b].$$

On a Vacuist semantics, however, the substitution of identicals holds no matter what the modal status of the antecedent is. Orthodox theorists conclude that this is an important advantage of the Vacuist semantics, and find there a reason to favour Vacuism over Nonvacuism.

In this paper, I first argue that the acceptance of premise 2, by Reformists and Orthodox alike is based on a subtle but harmful confusion between hyperintensionality and referential opacity. It can be proved that Nonvacuism entails that counterfactuals are hyperintensional. Although hyperintensionality is a consequence of opacity, on the assumption that the necessity of identity holds, there is no general converse implication from hyperintensionality to opacity (as 2 the existence of referentially transparent

hyperintensional context shows). The upshot is that there is no systematic reason for Reformists to accept that counterpossibles create opaque contexts. In fact, the only reason to do so is based on isolated intuitions such as:

- (3) a. If Hesperus had not been Phosphorus, then Hesperus would not have been Phosphorus.  
b. \*If Hesperus had not been Phosphorus, then Hesperus would not have been Hesperus.

I argue, second, that these intuitions should not be taken at face value but should be explained away as modal illusions. The upshot is that there is a way for the Reformist to meet the challenge of providing a uniform semantics for counterpossibles with respect to the substitution of identicals. The best Reformist response to the argument from uniformity above is then to deny premise 2 and resist opacity intuitions, or so I conclude.

### References

- Francesco Berto, Rohan French, Graham Priest, and David Ripley. Williamson on Counterpossibles. *Journal of Philosophical Logic*, online first.  
Berit Brogaard and Joe Salerno. Remarks on counterpossibles. *Synthese*, 190 (4):639–660, 2013.  
David K. Lewis. *Counterfactuals*. Blackwell, 1973.  
Robert C. Stalnaker. A Theory of conditionals. *American Philosophical Quarterly*, pages 98–112, 1968.  
Timothy Williamson. Counterpossibles in semantics and metaphysics. *Argumenta*, 2(2):195–226, 2017.

## When Worlds Collide: Isaac Newton and the Study of Chronology

Cornelis J. (Kees-Jan) Schilt

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Isaac Newton's studies of ancient history have not received the attention they deserve. This is partially due to the nature of the discipline, which is today non-existent as an individual topic; yet it is and remains a key part of historiography. According to a contemporary definition, found in the 1744 revision of John Harris' *Lexicon Technicum*, '[t]he great intention of chronology, is to set us right, with respect to [...] the exact course and order of time.' The chronologist's main instruments were 'the parts and characters of time, such as months, days, years, cycles, periods [...]' These computations frequently involved aligning the different calendars used by ancient civilizations, whose records had surfaced during the Renaissance, including those of Assyria and Egypt, and how they related to the chronology found in Scripture. From the early seventeenth century onward, chronologists' were confronted with seemingly reliable records of civilizations whose antiquity predated the biblical Flood, or even the date of Creation as calculated from Scripture.

The lack of attention to Newton's interests in chronology is also due to the fragmented nature of the manuscript corpus that contains the witnesses to Newton's deep engagement with the topic, which kept him occupied for the best of fifty years. But primarily, the key issue seems to be how alien Newton's scholarly studies, chronology in particular, are to both historians of science and historians of scholarship – and not just with Newton, but equally so with contemporaries such as Robert Boyle. That these two fields, science and scholarship, today so very disjointed, were much more closely connected back in the seventeenth century is still insufficiently recognized by modern historians.

In this paper, I will highlight a number of pivotal episodes from Newton's chronological studies with particular emphasis on how they connect with his other studies, including theology, natural philosophy, and alchemy, and how only an integral approach to Newton's oeuvre will put us on the right path to understanding the overall ideas Newton was working on and their key aspects.

## What is the History of Philosophy of Experimentation a History of?

Massimiliano Simons

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Philosophical reflections on experimentation seem to have a clear date of birth: the 1980s. At that time, philosophers, sociologists and historians seemed to suddenly turn to the topic of experiments in science. The clearest example is probably the ‘new experimentalism’ movement, with authors such as Ian Hacking, Peter Galison and Allan Franklin, arguing against a theory-focused view on science. But in a seemingly independent way, the same topic also came on the agenda for sociologists such as Harry Collins or Bruno Latour, historians such as Steven Shapin and Simon Schaffer, and philosophers such as Don Ihde and Hans Radder.

Though the proliferation of such studies on experimentation in the 1980s cannot be denied, at the same time it can easily be argued that experimentation has been a topic for philosophers well before that date, found extensively discussed in the work of earlier authors as diverse as Ernst Mach, Pierre Duhem, John Dewey, Edgar Wind or Percy Bridgman. The aim of this talk, however, is not to simply move the date of birth of philosophy of experimentation backwards in time with a century or so. Instead, I wish to use the long history of philosophy of experimentation to problematize the whole idea that there is a history to be told about philosophical reflections on a stable object, namely experimentation. Instead I will argue that the history of philosophy of experimentation has always been a plural history, constituted a hotbed of diverging conceptions of what function philosophical reflection on science should serve in the first place. The history of philosophy of experimentation thus shows the plurality of ways of what philosophy of science could be. I will illustrate this by focusing on two widely diverging cases of early reflections on experimentation: Hugo Dingler and Gaston Bachelard.

## Morphisms of Aristotelian Diagrams

Leander Vignero

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Several definitions of morphisms and isomorphisms of Aristotelian diagrams have recently been proposed. By Aristotelian diagrams, we mean couples  $(F, \mathbf{B})$  where  $F$  is a fragment of the Boolean algebra  $\mathbf{B}$  – this is essentially a generalized version of the definitions from the Demey-Smessaert tradition. The Boolean algebra imposes certain kinds of logical relations on the elements of  $F$ , the so-called Aristotelian relations. For instance, two elements  $x, y \in F$  may be  $\mathbf{B}$ -contrary. That is,  $(x \vee y) < 1_{\mathbf{B}}$  and  $x \wedge y = 0_{\mathbf{B}}$ .

Recently, Vignero (forthcoming) proposed to study Aristotelian diagrams by means of modern algebra. In this paper we would take a step back: we will consider several (new) ways of defining maps between Aristotelian diagrams. Specifically, we investigate the infomorphisms (Vignero 2021), Aristotelian morphisms and Boolean homomorphisms. All three of these are *prima facie* good candidates to serve as the structure-preserving maps of Aristotelian diagrams. Like Vignero, 2021 we will call the structure that is studied by those who are interested in Aristotelian diagrams opposition-implication structure. An infomorphism of diagrams is a function  $f : (F_1, \mathbf{B}_1) \rightarrow (F_2, \mathbf{B}_2)$  such that the image of  $F_1$  under  $f$  has an opposition-implication structure relative to the Boolean algebra  $\mathbf{B}_2$  that is at least as informative (in the Demey-Smessaert sense) as the opposition-implication structure of  $F_1$  relative to  $\mathbf{B}_1$ . In other words, infomorphisms map fragments to more or equally informative fragments. Aristotelian morphisms will restrict this requirement further: an Aristotelian morphism maps fragments of a given diagram to equally informative fragments. Finally, there are the Boolean diagrams. A map  $f : (F_1, \mathbf{B}_1) \rightarrow (F_2, \mathbf{B}_2)$  is a Boolean morphism if it is the restriction of a Boolean algebra morphism  $\varphi$  to  $F$ , or more formally:  $f = \varphi F_1$ .

The aim of this investigation is to chart the course for further algebraic work on Aristotelian diagrams. As Vignero (forthcoming) already pointed out, there are good reasons for approaching Aristotelian diagrams algebraically. For instance, some questions and constructions arise naturally in the algebraic setting and it is a great way of connecting the study of Aristotelian diagrams with other fields in logic and computer science.

## References

## **Two Routes to Relevance**

María Terrés Villalonga  
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Classical logic is the logic of truth-preservation. Truth-preservation, however, is not always a good guide for correct reasoning, as it does not guarantee a content connection between premises and conclusions in a classically valid inference. We will discuss two different routes found in the literature to make logical consequence relevant, and we will show how they can be seen as equivalent from the point of view of natural language.

The first option is to reject weakening - a structural rule valid in classical logic. However, this sub-structural solution has a cost: it invalidates certain apparently non-problematic valid inferences, such as Disjunctive Syllogism. In fact, the rejection of weakening leads to non-classical behaviours of the connectives. How to understand this new formal language that emerges from the rejection of weakening is open to debate, and some relevant logicians (see for instance [Read, 1988]) have argued that English connectives “and” and “or” are genuinely ambiguous between their two relevant counterparts. Another possible interpretation of the language is to claim that the relevant distinction of the connectives in LR corresponds to different pragmatic enrichments of the vocabulary.

The second strategy to make logical consequence relevant without stipulating deviant behaviours for the logical connectives is to reject transitivity and discriminate in classical logic those inferences which are relevant from those which are not. That is, to select those inferences that are nonproblematic in LK in a systematic way. See for instance [Tennant, 2017] and [Verde et al. 2019].

Although these two routes to relevance are philosophically divergent and have different views about the meaning of “follows from” and of logical vocabulary, we will argue that they are strongly connected. In particular, we claim that viewed from the perspective of natural language, the two routes have no real impact on how to reason relevantly with logical connectives in everyday reasoning.

**Contributed Papers (alphabetically by author)**

## **Toward a Unitary Epistemological Criterium for Empirical Knowledge**

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A certain number of epistemological criteria are usually acknowledged to be relevant in order to recognize genuine empirical knowledge. They are quite different depending on the field under study and usually not thought in a unitary way. For instance, Karl Popper’s methodological falsificationism (cf. [5], [2]) is sometimes thought as being efficient in fields like physics, whereas another notion of scientificity should apply to sciences the object of which is historical, like sociology (cf. [4]) or evolutionary biology (cf. [3].)

In this paper, against this dualist vision of science, I aim to define (empirical) scientific knowledge independently of a particular object of study. This definition takes the form of a general epistemological principle, i.e. a normative requirement applying to anything claiming to be scientific empirical knowledge. The elaboration of such a general principle is based on three fundamental distinctions: 1) discovery/justification context; 2) theoretical/empirical axioms; 3) analytic/synthetic statements.

I place my work in the context of justification, aiming to elaborate a normative criterium applying to conceptual corpus independently of their development history. Conceptual issues could appear about the two next distinctions (cf. [7], [6], [1].) Yet, their relevance depends on the scale at which a given theory is studied. In my work, I place myself at the scale of a model. At such a scale, by definition, the distinction between theoretical and empirical axioms can be made clear. Moreover, this

model's viewpoint allows to work as if the empirical part of a model and its explanatory part could be safely separated – and I focus here on the empirical part.

This allows to define scientific empirical knowledge merely as having to be made, at this scale, of empirical synthetic statements. I claim that this general principle: 1) is independent of the nature of the object under study; 2) allows to recover well-known empirical criteria once actualised within different research fields.

Examples will be taken from various fields. Further considerations about epistemological criteria applying to explanations are sketched in the conclusion.

## References

- [1] T. Kuhn. *The Structure of Scientific Revolutions*. ISSR collection. University of Chicago Press, 1996.
- [2] I. Lakatos. *The Methodology of Scientific Research Programmes: Philosophical Papers, Volume 1*. Cambridge University Press, 1978.
- [3] Ernst Mayr. *Darwin's Impact on Modern Thought. Proceedings of the American Philosophical Society*, 139(4): 317-325, 1995.
- [4] J.C. Passeron. *Le raisonnement sociologique. L'espace non-poppérien du raisonnement naturel*. Paris, Nathan, 1991.
- [5] K. Popper. *The Logic of Scientific Discovery*. Julius Springer. Hutchinson and Co., 1959.
- [6] W. V. Quine. On Empirically Equivalent Systems of the World. *Erkenntnis* (1975), 9(3): 313-328, 1975.
- [7] Willard Quine. *Two Dogmas of Empiricism*, pages 41-64. Springer Netherlands, 1976.

## Model-Based Reasoning, Scientific Representation and Fiction

Antoine Brandelet

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In recent years, the question of scientific representation has attracted the attention of many philosophers and has been much discussed (see for example the collection of articles edited by Mauricio Suárez (*Fictions in Science: Philosophical Essays on Modeling and Idealization*, Routledge, 2009)). Many conceptions oppose each other on different points of analysis, but the problematic is generally structured around the notion of model and its relation with scientific theories. The central question is therefore: what makes a scientific model represent the system under study?

Among the conceptions defended, one is based on a similarity between model-based reasoning and works of fiction [Frigg and Nguyen 2016]. This fictional view of models bases its analysis on Walton's concept of make-believe [Toon 2012]. According to its advocates, the scientist's attitude when using a model to represent a physical system is the same as when we are faced with a work of fiction: we pretend to believe what is told to us, even if we know that approximations, idealizations or fictions are integrated into the model. This conception therefore raises questions both about the explanatory capacity of models and about their ontological interpretation.

In this presentation, I will first show how the fictional conception of models allows us to answer some general problems of scientific representation. In particular, I will focus on the importance of taking into account the possibility of misrepresentation in an account of scientific representation and on the problems that this poses to purely structural conceptions of models.

Secondly, I will address the case of realism. If scientific realism states that science aims at truth, the fictional account I defend seems at first sight to promote anti-realism. I will show that this is not the case and that a realistic conception of scientific theories can accommodate the problem of misrepresentation.

## References

- Frigg, Roman and James Nguyen (2016). "The Fiction View of Models Reloaded". *The Monist* 99.3, pp. 225–242.

Toon, Adam (2012). *Models as Make-Believe*. Palgrave Macmillan.

## **The Making of a European Reactor in Belgium: Competition and Cooperation in Big Science (1990–2010)**

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Since 1995, the Belgian Nuclear Research Centre (SCK CEN) has been involved in the creation of a new nuclear research reactor in Mol. In 2010, the scientists managed to have their reactor – named MYRRHA – recognized as a priority on the list of the European Strategy Forum on Research Infrastructures. This type of initiatives has been described by historians as Big Science, being prestigious national scientific initiatives that occupy a unique place in the post-war scientific landscape. This paper aims to contribute to our understanding of contemporary Big Science by focusing on recent European initiatives to formalize the set-up of such research facilities.

A recent study has identified Big Science collaborations in Europe as ‘The Other Europe,’ a form of integration that developed in parallel to the European Economic Community, but which was not formally connected to it. From the 1980s onwards, however, science became increasingly recognized as a strategic goal of the EEC, and led to the introduction of formalized policies. Based on primary sources, this paper shows what role these policies played in the development of an initially small-scale Belgian reactor project to a large-scale European priority. In doing so, it will analyse how MYRRHA was shaped by competition and collaboration with other scientists through formal and informal networks in Europe.

More broadly, this paper aims to contribute to the growing historiographical literature on ‘New Big Science’, which addresses the ongoing transformation of Big Science research facilities and their position in current science policy. By analysing the organization of MYRRHA, this paper aims to enhance our view on the legitimization and coordination of Big Science in the recent history of science policy.

## **A Pointless Solution for Zeno’s Paradox of the Arrow**

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If one follows Russell’s hegemonic cinematographic account of change, it is nothing more than, for an entity, to have different properties at different times; i.e. a temporally ordered sequence of intrinsically static states of an entity. The success of this picture is easily explained as it allows one to have a resolution of Zeno’s paradoxes that fits their mathematical resolution through set theory, its concepts of limits and continuum, and the modelling of time by the real line (Grünbaum 1952, 1968). Analytic differential geometry being the basis of classical physics, Russell’s proposition carries over nicely into its ontology. Is change then necessarily reduced to the cinematographic picture in any ontology of physics?

It would be in as far as as nothing is dynamic here: two states in the sequence don’t overlap, the real line and the manifold of the models remaining separable, and instantaneous velocity, which should explain the transition between states, makes sense only as an abstraction of mean velocity. I claim however that the cinematographic picture is contingent, since it relies on the set theoretical notion of continuum and the use of analytic methods in mathematical physics. In fact, the rigorous development of Synthetic Differential Geometry, backed by the tools of category theory, gives us a new way to build mathematical models for spacetimes where the concept of continuum is a primitive non-reducible to points and Zeno’s paradoxes do not hold. The possibility of reconstructing Einstein’s equations under this formalism, despite the necessity to use intuitionist logic, gives weight to the probability for such a method to be equivalent to the usual one (even if no formal proof of physical equivalence has been given yet). This gives a basis to defend the non-necessity of Russell’s picture and the compatibility with “true change” for the ontology of any classical physical theory.

## **Some Thoughts on Tonk**

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A. Prior proposed the connective tonk as an objection to the doctrine to which the logical connectives' meaning is given by their logical rules in a proof system. This connective mixes the introduction of disjunction with the elimination of conjunction as its logical rules. According to the previous doctrine, the connective tonk is meaningful, but adding this connective to a logical language might trivialize the logic. There have been several attempts to solve the problem by refining the original philosophical doctrine. One such attempt is due to M. Dummett. We identify that at the core of Dummett's solution to the tonk problem lies the idea that our linguistic practices are open to criticism. Dummett proposed the distinction between the theory of meaning and a meaning-theory. The first one he reserves to be another name for the philosophy of language and the second he uses to designate a complete specification of the meaning of each expression belonging to a particular language. According to Dummett, the goal of the philosophy of language (the theory of meaning in his terminology) is to find universal principles, about the concept of meaning, upon which a formal meaning-theory can be construed. One of these principles is the harmony principle. Dummett's solution thus is to identify tonk as a particular case of failure of harmony. If there are ways of formalizing the principle of harmony on a logic level, for Dummett it is possible to prohibit the construction of a tonk-like connective. We explore an alternative Carnapian solution that diverges fundamentally with the idea that there are normative claims made about logical languages. Based on Carnap's Principle of Tolerance, it is not the logician's job to set up prohibitions upon logical systems. From this point of view, a logic that is tonk-admissible is neither "good" nor "bad", even though it might be the case that this logic lacks many formal properties that other logics might have.

## **Original Position Arguments and Social Choice under Ignorance**

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John Rawls famously argued that the Difference Principle would be chosen by any rational agent in the original position. Derek Parfit and Philippe Van Parijs have claimed, contra Rawls, that it is not the Difference Principle which is implied by Rawls' original position argument, but rather the more refined Lexical Difference Principle.

In this paper, we study both principles in the context of social choice under ignorance. First, we present a general format for evaluating original position arguments in this context. We argue that in this format, the Difference Principle can be specified in three conceptually distinct ways. We show that these three specifications give the same choice recommendations, and can be grounded in an original position argument in combination with the well-known maximin rule. Analogously, we argue that one can give at least four plausible specifications of the Lexical Difference Principle, which however turn out to give different recommendations in concrete choice scenarios. We prove that only one of these four specifications can be grounded in an original position argument. Moreover, this one specification seems the least appealing from the viewpoint of distributive justice. This insight points towards a general weakness of original position arguments.

## **Corrupter of Bodies? An Analysis of the *Verhandelingen* of the Batavian Society of Arts and Sciences (1778-1794) on Managing the Health of the Citizens of Batavia**

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During the early modern period, fears about the impact of the environment on the body incited colonial settlers to adopt strategies to prevent disease by managing their surroundings. This paper will investigate these practices in Dutch Batavia. The Batavian Society of Arts and Sciences, which was founded in 1778, published six volumes of *Verhandelingen (Treatises)* from 1779 until 1794. These *Verhandelingen* contain contributions on how to improve the dire health of the population in Batavia by relying on solutions such as cleaning out canals, ventilating homes, and keeping to a moderate diet. Interestingly, the advice in the *Verhandelingen* contrasts with earlier reports written in the context of government investigations that focused on large-scale interventions in the environment such as draining swamps and deviating rivers.

How can this shift in therapeutics from large-scale interventions in the environment to smaller-scale ones based on the non-naturals be explained? I will argue that the members of the Batavian Society directed their efforts toward a scale they deemed manageable. By focusing on new measures, they could keep up a health discourse that sustained the colonial project. First, I will look at the impasses the settlers faced with the great-scale interventions and their pessimism about “fighting nature”. Second, I will investigate how the different professional backgrounds and skills of the members of the Batavian Society converged in an interdisciplinary “medicine of the environment” that brought new health solutions.

### **The Genesis of the Queries in Isaac Newton’s *Opticks/Optice*: The Role of Allegiances and Rivalries**

Frederik Dhondt

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Isaac Newton’s *magna opera*, the *Principia* and the *Opticks*, gathered considerable attention upon their first and subsequent appearances. Reactions to the works were varied, seemingly creating “factions” of supporters and opponents. Many of the ensuing conflicts and their effects on contemporaneous debates, for example the Leibniz-Clarke correspondence, have already been extensively recorded and discussed. An episode that has received much less scholarly attention is the genesis of the Queries to the English *Opticks* and the Latin *Optice* in the years 1704-1717. Although the Queries have garnered ample attention ever since their first appearance, their development throughout the different versions of the *Opticks* (1704, 1717, 1721, and 1730) and the *Optice* (1706 and 1719) has been less thoroughly scrutinized. In this presentation, I analyse different drafts of both the *Optice* (1706) and the *Opticks* (1717) in search of the alliances and rivalries that inspired Newton to write his Queries. More specifically, I focus on those Queries that contain theology and/or methodology.

With regards to the *alliances*, I consider Samuel Clarke’s involvement in, and intellectual contributions to, the publication of the *Optice*. After the initial publication of the *Opticks* (1704) in English, Newton planned to publish a Latin version that was to be translated by Clarke. Additionally, Newton added seven Queries to that version, concerned with subjects such as theology, methodology, chemistry etc. Beyond his work of translation, commentators are unclear about the extent to which Clarke contributed to those new Queries. By looking at the draft material to the *Optice*, I argue that previously unnoticed marginal notes in Clarke’s hand indicate that he was intellectually invested in the process of writing and editing some of the Queries.

This draft material, as well as that prepared for the 1717 edition, also attests to Newton’s urge to react to his *adversaries* in writing. Even though he softened or redirected many of his responses in the published versions, they are often still present in a latent form. This allows one to retrace the development of many of the famous Queries and identify Newton’s inspiration for them.

### **An Agent-Based Interpretation of the Doctrinal Paradox**

Sacha Ferrari

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This paper proposes a new interpretation of the doctrinal paradox by considering an agent-based decision process instead of a majority voting one. Our aim is to investigate how often the doctrinal paradox occurs in an interacting community. This paradox occurs when the final sentence of a deliberating process is in contradiction with its two premises. The implemented model we chose is a multivariate improvement of the Hegselmann-Krause opinion dynamic model [1]. We considered that each individual averages his/her prior opinion with those of the other agents' if these agents are located within his/her bound of confidence. We simulated millions of random initial communities and let them evolve. At the end of the interaction process, we assessed how many of them led to an opinion configuration in which the doctrinal paradox is present. Consequently, a quantitative comparison between majority-voting and agent-based generated final sentences has been performed. Two surprising results emerged. First, in at least 92% of the cases, the two procedures end up with exactly the same decision. Secondly, the latter is irrational a quarter of the time (on average) in both models. Which means that the doctrinal paradox occurs regardless of the presence of interaction between agents.

To make our model even more realistic, we considered our agents as confirmation biased: if two agents A and B are in conflict concerning belief  $p$ , the more A has beliefs in common with B, the more A will be prone to take into account B's opinion concerning  $p$ . By considering this confirmation bias in our model, for a large number of agents, majority voting leads to 7% fewer irrational decisions than an agent-based model. These results raise some moral issues about the usefulness of public debate in decision making.

## References

[1] Hegselmann, R., Krause, U. (2002). Opinion dynamics and bounded confidence models, analysis, and simulation. *Journal of artificial societies and social simulation* 5(3).

## Generalizing Aristotelian Relations to Sets of Formulas

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The famous Aristotelian square of opposition gives rise to four Aristotelian relations: contradiction (CD), contrariety (C), subcontrariety (SC), and subalternation (SA). The study of these relations has a long history in philosophical logic. Recently, the square and the four relations have been noted for their informativity, and have found applications in fields as diverse as computer science, cognitive science and linguistics.

The four Aristotelian relations have traditionally been defined as relations between two formulas. In this talk, I will show that these relations can be generalized to relations between non-empty sets of formulas. I show that this generalization can be defined in such a way that the relations between the Aristotelian relations are preserved. For example, for the traditional relations the following holds. Given a suitable logic  $\mathbf{S}$  and language  $\mathbf{L}$  of  $\mathbf{S}$ , for any formulas  $\varphi, \psi, \chi \in \mathbf{L}$  such that  $\varphi$  is CD to  $\psi$ :

$$\chi \text{ and } \psi \text{ are in SA iff } \chi \text{ and } \varphi \text{ are C.}$$

A similar relation holds for the generalized relations  $\text{CD}'$ ,  $\text{C}'$ , and  $\text{SA}'$ . For any sets of formulas  $\Gamma, \Delta, \Theta \subseteq \mathbf{L}$  such that  $\Gamma$  is  $\text{CD}'$  to  $\Delta$ :

$$\Theta \text{ and } \Delta \text{ are in SA}' \text{ iff } \Theta \text{ and } \Gamma \text{ are C}'.$$

This generalized definition of the four Aristotelian relations gives rise to new geometric figures, including a new square of opposition. These differ from the traditional figures in that they have sets of formulas instead of individual formulas at the corners.

I will end the talk by showing that there are multiple possible generalizations, some of which also preserve the relations between the Aristotelian relations. These different generalizations capture different intuitive understandings of the traditional Aristotelian relations. I will discuss how this fact can affect our understanding of the traditional relations.

## **Berkeley and Kant on the Limits of Knowledge and Science: A Historical, Conceptual and Logical Investigation**

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This paper discusses the limits of knowledge and science according to the anti-realist theories of knowledge of Berkeley and Kant while taking into account contemporary insights from discussions about epistemic paradoxes. I first analyse and compare their anti-realist positions. After reaching an understanding of their positions, I discuss how knowledge and science are possible and what kind of truth theories are accepted by Berkeley and Kant. This allows us to move forward and understand whether they accept that all truths are knowable. After discussing Berkeley's and Kant's accounts of knowability, I briefly touch on the knowability paradox known as the Fitch paradox, which inevitably arises in the scope of antirealism. Fitch has already shown that the knowability thesis, which involves a non-factive notion of knowability, faces omniscience by stating that if every truth is knowable, then every truth is known. I aim to analyse Berkeley's and Kant's approaches and see whether they avoid or accept this undesirable conclusion.

The paper proceeds as follows. Section I focuses on Berkeley's subjective idealism and describes Berkeley's reasoning. By discussing Berkeley's theory of knowledge, particularly his truth theory, and by reconstructing his knowability approach, I finally formulate his knowability concept, showing that Berkeley accepts factive knowability according to which only truths are perceivable. Even though factive knowability could avoid human omniscience, Berkeley leaves us with some ambiguities regarding this topic. In the case of one of the possible interpretations of his text, human knowability collapses human knowledge. Section II explores Kant's transcendental idealism, Kant's understanding of scientific knowledge and truth, and eventually the knowability concept, according to which all empirical truths are knowable. I also discuss Kant's approach to human omniscience, showing that we inevitably face human omniscience using Fitch-style reasoning, while Kant never openly claims it. Moreover, adopting the concept of the extension of the content of empirical knowledge, he leaves room for the existence of unknown empirical truths to be known in the future. Finally, section III contrasts the results of the first two sections by highlighting the similarities and differences between Berkeley's and Kant's positions on the limits of knowledge and science.

## **Can a Transfinite Turing Machine solve 3-SAT $\aleph_0$ in a Cantor Space?**

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Let 3-SAT $\aleph_0$  be the problem obtained by adding to 3-SAT a countable infinite number of clauses and variables. Any solution of this problem can be expressed in a cantor space  $\{0, 1\}^{\aleph_0}$ . Checking if  $s \in \{0, 1\}^{\aleph_0}$  is a solution can be done in  $\aleph_0$  steps, but finding one by brute force takes  $\aleph_1$  iterations in almost all cases. The question addressed by this paper is the following: is there an implication between  $P = NP$  conjecture and the problem of solving 3-SAT $\aleph_0$  in a countable time?

First, a  $\mathbf{T}_{\omega_1}$  transfinite extension of Turing machine will be introduced. When executed for a finite time,  $\mathbf{T}_{\omega_1}$  and a classical Turing machine are indistinguishable. But when the number of steps reaches  $\omega_0$ , complex discrepancies can appear. Unlike Turing machines with Oracle,  $\mathbf{T}_{\omega_1}$  is provided with an explicit description. Moreover, the definition of  $\mathbf{T}_{\omega_1}$  leads to a generalization of Rice's theorem that specifies what kind of implications exist between finite and infinite machines. It will be shown that some questions concerning their mutual relationships cannot be solved, including most  $P = NP$  conjecture relevant questions.

In the second part, a time countable algorithm for 3-SAT $\aleph_0$  will be provided. In this purpose, a geometric representation of the problem will be put forward, where the domain of admissible solutions

can be assimilated to the line segment  $[0, 1]$ . The clauses themselves will be expressed by means of periodic functions cancelling out on certain key values of  $[0, 1]$ .

In conclusion, the present paper intends to take five contributions: (1) introducing a new tool in hypercomputation theory, (2) showing that  $3\text{-SAT}_{\aleph_0}$  is soluble in a countable number of steps, (3) providing a geometric representation of 3-SAT, (4) discussing some new strategical ideas concerning  $P = NP$  conjecture and (5) concluding with an informal and open-to-debate philosophical argument about the deductive power of a transfinite Turing Machine compared to human mind.

## Can Relations have Ontological Primacy?

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In this presentation, I discuss the ontological importance given to relations. I will explore two ways of thinking a relational ontology. The first one is developed in non-standard approaches of emergence, in works of philosophers such as Humphreys (2016) and Santos (2020). In those approaches, relational ontology is understood in a way that relational processes are qualitatively transformative (Santos 2015). Relations thus have ontological power to transform relata. Nonetheless, Santos (2015) argues that it makes no sense to give ontological priority to one of the two ontological categories, relations and relata. They are mutually defining and imply each other.

But the second approach I am interested in might lead to another direction. In relational biology (Rashevsky 1954 & 1961, Rosen 1958 & 1991), the importance given to relations is firstly epistemological. Relational biology aims to create a mathematical model for living systems and, in that purpose, it focuses on the internal organization of such systems. The theory of categories, the mathematical tool used in relational biology (Rosen 1958), contains the possibility of giving primacy to relations over objects, thanks to, for example, the identity morphism. Even though Rosen and relational biologists stay on an epistemological level when they say “throw away the matter and keep the underlying organization” (Rosen 1991), I suggest considering this stance on an ontological level. In that sense, relations might ontologically prevail over relata.

I will question the distinction between those two positions and place them among other relational ontologies, Nietzschean and Heraclitean especially (Carli 2016). I will also compare them to non-substantialist ontologies as those that can be found in Ruyer’s (1930) and Simondon’s (1964) works.

### References

- CARLI, R., “Relational Ontology in Nietzsche: An Introduction”, *Parrhesia*, n°26 (2016), 96-116.  
HUMPHREYS, P., *Emergence. A Philosophical Account*, Oxford: Oxford University Press, 2016.  
RASHEVSKY, N., “Topology and Life: In Search of General Mathematical Principles in Biology and Society”, *Bulletin of Mathematical Biophysics*, vol. 16 (1954), pp. 317-348.  
RASHEVSKY, N., “Abstract Mathematical Molecular Biology” in *Bulletin of Mathematical Biophysics*, vol. 23 (1961), pp. 237-260.  
ROSEN, R., “The Representation of Biological Systems from the Standpoint of the Theory of Categories”, *Bulletin of Mathematical Biophysics*, vol. 20 (1958), pp. 317-341.  
ROSEN, R., *Life Itself. A Comprehensive Inquiry Into The Nature, Origin, And Fabrication Of Life*, New York, Columbia University Press, 1991.  
RUYER, R., *Esquisse d'une philosophie de la structure*, Paris, Librairie Félix Alcan, 1930.  
SANTOS, G. C., “Ontological Emergence: How is that possible? Towards a new Relational Ontology”, *Foundations of Science*, 20 (2015), pp. 429-446.  
SANTOS, G. C., “Integrated-structure emergence and its mechanistic explanation”, *Synthese* (2020).  
SIMONDON, G., *L'individuation à la lumière des notions de forme et d'information*, Paris, PUF, 1964.

### Smeaton’s Early Research on Electricity

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In this talk, I would like to provide an overview of eighteenth-century English engineer John Smeaton's early research on electricity. Although he is most well-known for his career as a civil engineer, Smeaton first trained as a scientific instrument maker. He made improvements to Hauksbee's air pump and designed a friction machine used by his childhood friend Benjamin Wilson (1721-1788)— a painter and electrical experimenter. Smeaton's first scholarly publication was a short article on some experiments on the velocity of electricity that he carried out with Wilson, and that appeared in an issue of the *Gentleman's Magazine* of 1747. In this paper, we already find evidence of Smeaton's method of parameter variation that came to characterize his later research. Following this, electrical experiments carried out by Smeaton are mentioned in Wilson's *Treatise on Electricity* (1750). In a paper from 1752, William Watson (1715-1787), another leading electrical experimenter of the period, thanked Smeaton for making the experimental apparatus he required, which was built around Smeaton's improved air pump. Of particular interest from a methodological standpoint are some experiments of Watson's on electricity in a vacuum – using Smeaton's own air pump – that Smeaton subsequently repeated. According to Joseph Priestley (1733-1804), Smeaton's set of experiments were “in several respects, similar to those made by Dr. Watson, and yet are attended with a considerable variety of circumstances.” I will focus on whether this was because Smeaton's more open-ended method of parameter variation differed from that of his contemporaries.

### **Opening up HPS-Debates: On Reading Kuhn and the History of the Quantum**

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Since a few decades, historical studies of the early quantum have taken a meta-historical turn: they are interested not only in how Planck saw the discrete energy elements he introduced, but also in how to study this question historically. This is a consequence of Thomas Kuhn's work on the quantum, in which he argues, against the standard view of Planck as the first to introduce the quantum, that Planck, for a long time, understood his work in classical, continuous terms.

In this talk, I will argue that most meta-historical responses to Kuhn's book read it with a theory-driven understanding of paradigms in mind, and that Kuhn's book should actually be read in practice-focused terms. Such a practice-focused reading comes down to the claim that Planck's early work on black bodies should not be read as a theory, but rather as a collection of techniques, borrowed from Ludwig Boltzmann and transformed to suit the problem at hand. One advantage of this reading is that we do not need to ascribe to Planck any substantially worked out stance, either classical or quantum, with regards to the question of how he saw energy.

On the basis of this, I will then argue that the meta-historical debate focuses too much on the relation with Kuhn's work on *The Structure of Scientific Revolutions*, and too little on the work that Kuhn carried out after *Structure*, and before he started his book on Planck, primarily the interviews he conducted with physicists for the *Archive for the History of Quantum Physics*. This will suggest that after *Structure*, and partially because of his engagement with oral history, Kuhn came to understand paradigms more and more in practice-focused terms.

### **Hyperintensionality, Opacity, and Counterpossibles**

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Can counterpossibles be false? The Orthodox doctrine of Vacuism is that all counterpossibles are vacuously true [Stalnaker, 1968, Lewis, 1973, Williamson, 2017]. However a number of Reformists defend the contradictory view, i.e. Nonvacuism, that some counterpossibles, at least, are best regarded as false rather than vacuously true [Brogaard and Salerno, 2013, Berto et al., 2017]. One reason to remain

with the Orthodoxy [Williamson, 2017] is that Nonvacuism fails to account for the objectivity of counterfactuals. The argument can be reconstructed as follows:

1. Counterfactuals, in general, express a non epistemic relation between the antecedent and the consequent.
2. If Nonvacuism is true, then counterpossibles are referentially opaque.
3. If counterpossibles are referentially opaque, they express an epistemic relation between the antecedent and the consequent.
4. Therefore Nonvacuism is false.

Some Reformists are happy to accept that counterpossibles are epistemic, unlike non-counterpossible counterfactuals, and reject 1 [Brogaard and Salerno, 2013]. Others claim that they can provide simultaneously non epistemic and referentially opaque counterpossibles Berto et al. [2017], and thus reject 3. The Orthodox [Williamson, 2017, e.g.] can then retort that both moves end up giving counterfactuals an implausibly hybrid logic, where some substitution principles hold only for possible antecedents, but not for impossible ones. For example, one would have

$$(1) a = b, \diamond A, A \Box \rightarrow B \vdash A \Box \rightarrow B [a/b]$$

but

$$(2) a = b, A \Box \rightarrow B \not\vdash A \Box \rightarrow B[a/b].$$

On a Vacuist semantics, however, the substitution of identicals holds no matter what the modal status of the antecedent is. Orthodox theorists conclude that this is an important advantage of the Vacuist semantics, and find there a reason to favour Vacuism over Nonvacuism.

In this paper, I first argue that the acceptance of premise 2, by Reformists and Orthodox alike is based on a subtle but harmful confusion between hyperintensionality and referential opacity. It can be proved that Nonvacuism entails that counterfactuals are hyperintensional. Although hyperintensionality is a consequence of opacity, on the assumption that the necessity of identity holds, there is no general converse implication from hyperintensionality to opacity (as 2 the existence of referentially transparent hyperintensional context shows). The upshot is that there is no systematic reason for Reformists to accept that counterpossibles create opaque contexts. In fact, the only reason to do so is based on isolated intuitions such as:

- (3) a. If Hesperus had not been Phosphorus, then Hesperus would not have been Phosphorus.
- b. \*If Hesperus had not been Phosphorus, then Hesperus would not have been Hesperus.

I argue, second, that these intuitions should not be taken at face value but should be explained away as modal illusions. The upshot is that there is a way for the Reformist to meet the challenge of providing a uniform semantics for counterpossibles with respect to the substitution of identicals. The best Reformist response to the argument from uniformity above is then to deny premise 2 and resist opacity intuitions, or so I conclude.

## References

- Francesco Berto, Rohan French, Graham Priest, and David Ripley. Williamson on Counterpossibles. *Journal of Philosophical Logic*, online first.
- Berit Brogaard and Joe Salerno. Remarks on counterpossibles. *Synthese*, 190 (4):639–660, 2013.
- David K. Lewis. *Counterfactuals*. Blackwell, 1973.
- Robert C. Stalnaker. A Theory of conditionals. *American Philosophical Quarterly*, pages 98–112, 1968.
- Timothy Williamson. Counterpossibles in semantics and metaphysics. *Argumenta*, 2(2):195–226, 2017.

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Isaac Newton's studies of ancient history have not received the attention they deserve. This is partially due to the nature of the discipline, which is today non-existent as an individual topic; yet it is and remains a key part of historiography. According to a contemporary definition, found in the 1744 revision of John Harris' *Lexicon Technicum*, '[t]he great intention of chronology, is to set us right, with respect to [...] the exact course and order of time.' The chronologist's main instruments were 'the parts and characters of time, such as months, days, years, cycles, periods [...]' These computations frequently involved aligning the different calendars used by ancient civilizations, whose records had surfaced during the Renaissance, including those of Assyria and Egypt, and how they related to the chronology found in Scripture. From the early seventeenth century onward, chronologists' were confronted with seemingly reliable records of civilizations whose antiquity predated the biblical Flood, or even the date of Creation as calculated from Scripture.

The lack of attention to Newton's interests in chronology is also due to the fragmented nature of the manuscript corpus that contains the witnesses to Newton's deep engagement with the topic, which kept him occupied for the best of fifty years. But primarily, the key issue seems to be how alien Newton's scholarly studies, chronology in particular, are to both historians of science and historians of scholarship – and not just with Newton, but equally so with contemporaries such as Robert Boyle. That these two fields, science and scholarship, today so very disjointed, were much more closely connected back in the seventeenth century is still insufficiently recognized by modern historians.

In this paper, I will highlight a number of pivotal episodes from Newton's chronological studies with particular emphasis on how they connect with his other studies, including theology, natural philosophy, and alchemy, and how only an integral approach to Newton's oeuvre will put us on the right path to understanding the overall ideas Newton was working on and their key aspects.

### **What is the History of Philosophy of Experimentation a History of?**

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Philosophical reflections on experimentation seem to have a clear date of birth: the 1980s. At that time, philosophers, sociologists and historians seemed to suddenly turn to the topic of experiments in science. The clearest example is probably the 'new experimentalism' movement, with author such as Ian Hacking, Peter Galison and Allan Franklin, arguing against a theory-focused view on science. But in a seemingly independent way, the same topic also came on the agenda for sociologists such as Harry Collins or Bruno Latour, historians such as Steven Shapin and Simon Schaffer, and philosophers such as Don Ihde and Hans Radder.

Though the proliferation of such studies on experimentation in the 1980s cannot be denied, at the same time it can easily be argued for that experimentation has been a topic for philosophers well before that date, found extensively discussed in the work of earlier authors as diverse as Ernst Mach, Pierre Duhem, John Dewey, Edgar Wind or Percy Bridgman. The aim of this talk, however, is not to simply move the date of birth of philosophy of experimentation backwards in time with a century or so. Instead, I wish to use the long history of philosophy of experimentation to problematize the whole idea that there is a history to be told about philosophical reflections on a stable object, namely experimentation. Instead I will argue that the history of philosophy of experimentation has always been a plural history, constituted a hotbed of diverging conceptions of what function philosophical reflection on science should serve in the first place. The history of philosophy of experimentation thus shows the plurality of ways of what philosophy of science could be. I will illustrate this by focusing on two widely diverging cases of early reflections on experimentation: Hugo Dingler and Gaston Bachelard.

### **Morphisms of Aristotelian Diagrams**

Several definitions of morphisms and isomorphisms of Aristotelian diagrams have recently been proposed. By Aristotelian diagrams, we mean couples  $(F, \mathbf{B})$  where  $F$  is a fragment of the Boolean algebra  $\mathbf{B}$  – this is essentially a generalized version of the definitions from the Demey-Smessaert tradition. The Boolean algebra imposes certain kinds of logical relations on the elements of  $F$ , the so-called Aristotelian relations. For instance, two elements  $x, y \in F$  may be  $\mathbf{B}$ -contrary. That is,  $(x \vee y) < 1_{\mathbf{B}}$  and  $x \wedge y = 0_{\mathbf{B}}$ .

Recently, Vignero (forthcoming) proposed to study Aristotelian diagrams by means of modern algebra. In this paper we would take a step back: we will consider several (new) ways of defining maps between Aristotelian diagrams. Specifically, we investigate the infomorphisms (Vignero 2021), Aristotelian morphisms and Boolean homomorphisms. All three of these are *prima facie* good candidates to serve as the structure-preserving maps of Aristotelian diagrams. Like Vignero, 2021 we will call the structure that is studied by those who are interested in Aristotelian diagrams opposition-implication structure. An infomorphism of diagrams is a function  $f: (F_1, \mathbf{B}_1) \rightarrow (F_2, \mathbf{B}_2)$  such that the image of  $F_1$  under  $f$  has an opposition-implication structure relative to the Boolean algebra  $\mathbf{B}_2$  that is at least as informative (in the Demey-Smessaert sense) as the opposition-implication structure of  $F_1$  relative to  $\mathbf{B}_1$ . In other words, infomorphisms map fragments to more or equally informative fragments. Aristotelian morphisms will restrict this requirement further: an Aristotelian morphism maps fragments of a given diagram to equally informative fragments. Finally, there are the Boolean diagrams. A map  $f: (F_1, \mathbf{B}_1) \rightarrow (F_2, \mathbf{B}_2)$  is a Boolean morphism if it is the restriction of a Boolean algebra morphism  $\varphi$  to  $F$ , or more formally:  $f = \varphi F_1$ .

The aim of this investigation is to chart the course for further algebraic work on Aristotelian diagrams. As Vignero (forthcoming) already pointed out, there are good reasons for approaching Aristotelian diagrams algebraically. For instance, some questions and constructions arise naturally in the algebraic setting and it is a great way of connecting the study of Aristotelian diagrams with other fields in logic and computer science.

## References

L. Vignero. Combining and Relating Logical Diagrams, forthcoming in A. Basu et al. (eds), *Diagrams 2021*, Series: Lecture Notes in Artificial Intelligence.

## Two Routes to Relevance

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Classical logic is the logic of truth-preservation. Truth-preservation, however, is not always a good guide for correct reasoning, as it does not guarantee a content connection between premises and conclusions in a classically valid inference. We will discuss two different routes found in the literature to make logical consequence relevant, and we will show how they can be seen as equivalent from the point of view of natural language.

The first option is to reject weakening - a structural rule valid in classical logic. However, this sub-structural solution has a cost: it invalidates certain apparently non-problematic valid inferences, such as Disjunctive Syllogism. In fact, the rejection of weakening leads to non-classical behaviours of the connectives. How to understand this new formal language that emerges from the rejection of weakening is open to debate, and some relevant logicians (see for instance [Read, 1988]) have argued that English connectives “and” and “or” are genuinely ambiguous between their two relevant counterparts. Another possible interpretation of the language is to claim that the relevant distinction of the connectives in LR corresponds to different pragmatic enrichments of the vocabulary.

The second strategy to make logical consequence relevant without stipulating deviant behaviours for the logical connectives is to reject transitivity and discriminate in classical logic those

inferences which are relevant from those which are not. That is, to select those inferences that are nonproblematic in LK in a systematic way. See for instance [Tennant, 2017] and [Verde et al. 2019].

Although these two routes to relevance are philosophically divergent and have different views about the meaning of “follows from” and of logical vocabulary, we will argue that they are strongly connected. In particular, we claim that viewed from the perspective of natural language, the two routes have no real impact on how to reason relevantly with logical connectives in everyday reasoning.