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FORMAL METHODS AND SCIENCE IN PHILOSOPHY V

Inter-University Centre, Dubrovnik, Croatia
May 16–18, 2024

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Conference venue:

Inter-University Centre, Ul. don Frana Bulića 4, Dubrovnik, Croatia

Contents

ABSTRACTS

Keynote lectures

How a Model of Event Cognition can be Applied to Causal Reasoning and Verb Semantics

PETER GÄRDENFORS
Lund University, Sweden

I present a cognitive model of event structure that can be used to explain several features of causal reasoning and the semantics of natural language. The model consists of four basic components: agent, patient, force vector and result vector. Each component is described in terms of the theory of conceptual spaces. The force vector is the cause of the result vector. The model provides a force dynamic representation of causation. I discuss how the mapping from cause to effect can be learnt. I will briefly show how the model can explain semantic features of verbs, for example manner-result complementarity, the ambiguity of the passive participle, and verb metaphors.

Logics for Strategic Reasoning about Socially Cooperative Rational Agents

VALENTIN GORANKO
Stockholm University, Sweden

In this talk I will discuss logic-based reasoning about strategic abilities of rational individuals (agents) and groups (coalitions) of individuals to guarantee achievement of their goals, while acting with cooperative attitude within the entire society of agents.

Since the early 2000s several logical systems have been proposed for formalising and capturing strategic reasoning in multi-agent systems, starting with the Coalition Logic (CL), the Alternating Time Temporal Logic (ATL) and some extensions of these. Coalition Logic provides a natural, but rather extreme perspective: the agents in the proponent coalition are viewed as acting in full cooperation with each other but in complete opposition to all agents outside of the coalition, which are thus treated as their adversaries. The Alternating Time Temporal

Logic extends Coalition Logic with temporal operators allowing for expressing long-term temporised goals.

The strategic interactions in real life are much more complex, usually involving various patterns combining cooperation and competition. To capture these, more expressive and versatile logical systems are needed and I will briefly mention in the talk some such recently proposed logical systems.

I will then present the Socially Friendly Coalition Logic (SFCL), enabling formal reasoning about strategic abilities of individuals and groups to ensure achievement of their private goals while allowing for cooperation within the entire society. I will present the language and formal semantics for this logic and will illustrate and discuss its use with examples. Time permitting, I will then discuss some more technical questions around axiomatisation and decidability of its validities.

The talk is partly based on the following papers:

Valentin Goranko and Sebastian Enqvist: Socially Friendly and Group Protecting Coalition Logics, Proc. of AAMAS'2018, IFAAMAS publ., 2018, pp 372-380. Online link: http://ifaamas.org/Proceedings/aamas2018/pdfs/p372.pdf .

Valentin Goranko: Logics for Strategic Reasoning of Socially Interacting Rational Agents: An Overview and Perspectives. Logics, vol. 1, 2023, pp. 4-35. Online link: https://www.mdpi.com/2813-0405/1/1/3

Reflection in the Mathematical Sciences

LEON HORSTEN
University of Konstanz, Germany

This general talk discusses the role of reflection and reflection principles in the mathematical sciences. A distinction is made between ontological and epistemic reflection, and a corresponding distinction between ontological and epistemic reflection principles. Ontological reflection plays an important role in set theory; epistemic reflection principles play an important role in proof theory. I will also briefly discuss probabilistic reflection principles, which play a significant role in formal epistemology. The question of our epistemic warrant for reflection principles will be the main theme of the talk. I will close with what I take to be important open philosophical questions about reflection in the mathematical sciences.

My References on Logic Education

MARÍA MANZANO
University of Salamanca, Spain

I would like to present several initiatives taken by important logicians who were closely involved not only in logic research but also in its disseminating and teaching. As the title suggests, I am going to focus on just a few of them, the ones I am very happy and honored to have been influenced by on this subject: Leon Henkin, Wilfrid Hodges, Johan van Benthem, Dov Gabbay, Zalta and Patrick Blackburn.

Among the actions to promote logic, I highlight the collaboration between teachers and students at all levels, including university as well as previous educational stages. Master's and doctoral programs are relevant, but also summer schools, conferences and projects dedicated to logic and his pedagogy, where we can discuss what to teach and how with mathematicians, computer scientist, linguistics, and philosophers. The creation of Journals, Handbooks, Encyclopedias and Collections of books devoted to logic, as well as the foundation of important groups dedicated to teaching and research in logic are among the relevant contributions of my references on Logic Education.

The general question is. What should be done today?

Talks

Splitting Truth in Hybrid First-Order Logic

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MARA MANZANO
University of Salamanca, Spain

MANUEL MARTINS
University of Aveiro, Portugal

The formal language of Hybrid First-Order Logic extends First-Order Logic with nominals, satisfaction and modal operators. The signature contains function, relation symbols and equality, where function and relation symbols are interpreted intensionally and functions may be partial. Our semantics is Kripke tyle with non-constant domains, but some definitions are changed to deal with two different notions of local truth. Quantification domains change from world to world, but we also allow a "Phantom Zone", where denoting but non existing individuals live. In a previous paper [1], a similar semantics was defined and non-denoting terms were considered. However, formulas were always true or false. The important contribution of the present work is that we split truth into two different kinds, so we are in a three-valued logic. In "Hybrid Partial Type Theory" (Manzano et al 2023), non-denoting expressions are also taken into account, but the logic remains bivalent. Working in this system, we realized that there are two degrees of truth: formulas that are true but talk about individuals outside the evaluation world and true formulas talking about existing entities in that world.

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A belief–Action Interaction Model for Social Epistemology

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Social epistemology [1] is a lively research field that studies the social aspects of belief formation in general and knowledge production in particular. Among the great diversity of approaches that exist in this field, formal methods are of great

interest, like e.g. the Hegselmann-Krause model [2] in which agents form a belief by interacting with each other, under certain conditions. In this talk, I would like to present a similar model of collective belief formation, but where *actions* of agents are taken into account in addition to their beliefs. More precisely, every agent forms a certain belief *and* also does an action with respect to this belief and to other agents' beliefs and actions. This model is intended to represent the way interacting individuals form beliefs and act collectively in different specific conditions, as a framework for a systematic study of the conflict and balance between individual search for cognitive consonance and social forces constraining individual actions. This formal approach would help to clarify and address important philosophical questions about individual and collective rationality in general, applied particularly to collective production of knowledge.

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The LogiKEy Methodology: Applications in AI Ethics and Prospects in Logic Teaching

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DAVID FUENMAYOR
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LogiKEy [3,2] is a methodology and framework for integrating logic-based formal methods, knowledge engineering, and ethico-legal reasoning. It uses classical higher-order logic (HOL) as a unifying foundation for logico-pluralistic reasoning in combinations of (non-classical) logics [1], thereby offering expressiveness and flexibility beyond first-order logic. LogiKEy aids in developing normative theories, combining modal, deontic, and epistemic logics (among others). Its goal is to tackle challenges in ethical AI and machine ethics by providing tools for formalizing and reasoning about complex ethical concepts and principles. The approach is interdisciplinary, bridging gaps between computer science, philosophy, and law [1,2], and facilitates rigorous and transparent reasoning in ethically-sensitive AI systems [4].

Recently, we have begun implementing an approach for uniformly teaching logic(s) at the undergraduate level to mixed groups of computer science, mathematics, and philosophy students. This approach, supported by automated reasoning tools, is based on the logico-pluralistic LogiKEy methodology. It notably harnesses interactive and automated theorem proving technologies, as integrated into modern mathematical proof assistants (in particular Isabelle/HOL, due to its excellent automation support). The course, suggestively called "universal logical reasoning", has been taught twice at the University of Bamberg during the last two winters. We plan to discuss our experience in the talk.

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Epistemic Type Mismatch

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In the field of knowledge representation in computer science, expert systems exploit knowledge bases by inferential means in order to acquire knowledge. [1] Inference engines in expert systems do not alter the epistemic properties of statements that are parts of an inference, i.e., the inferred knowledge is of the same type as the knowledge in the premises. [2] In this perspective, the concept of knowledge is conceived as being *univocal* and as being closed under material implication. In other words, if one knows that ϕ and one knows that $\phi \supset \psi$, then one knows *in the same sense* that ψ. Such a univocal concept of knowledge is clearly adequate when an agent is drawing conclusions from a single knowledge base, or even many if all the declarative knowledge involved is of the same type. But what if different types of knowledge (concepts of knowledge) are intermingled? For instance, if one has *perceptual* knowledge that ϕ and *logical* knowledge that $\phi \supset \psi$, then what kind of knowledge does one have that ψ? I will defend the idea that, when reasoning about knowledge, knowledge types must be differentiated,

and that in a knowledge representation where there are no distinctions between knowledge types inferences may generate epistemic equivocity. In the first part of the talk, I will present the problem of epistemic type mismatch. I will show that this problem puts into light some sort of epistemic equivocity lurking in inferential knowledge, and that it calls for some logical refinements with respect to the representation of inferential knowledge. In the second part, I will address this issue from a model-theoretic point of view, and I will present a fragment of epistemic logic [3] capable of providing a solution to the problem of epistemic type mismatch.

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Moderate Reconstructionism as a Metaphilosophical Standpoint

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In 1964, Janina Kotarbińska, a prominent female representative of the Lvov-Warsaw School, published a paper titled "Spór o granice stosowalności metod lgicznych" [The Controversy about the Limits of Applicability of Logical Methods]. In this exemplary study, she presents and contrasts two tendencies in analytic philosophy: reconstructionism and descriptionism, comparing their approaches to three methodological procedures—analysis of concepts, reconstruction of reasoning, and axiomatizing theories. Kotarbińska adeptly highlights misunderstandings and mistakes in both approaches, positioning herself as a moderate reconstructionist, namely a supporter of judicious and cautious application of logical methods in philosophical investigations. The purpose of my paper is to demonstrate that moderate reconstructionism has been a widely accepted position within the Lvov-Warsaw School, a Polish branch of analytic philosophy, since its inception around 1900. This stance naturally emerged as a result of the tension between Kazimierz Twardowski's descriptive approach to philosophical disciplines and Jan Łukasiewicz's program of "logicization" of philosophy. I will argue that the objectives, methodologies, and outcomes of moderate reconstructionism remain appealing in contemporary times as well.

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Arbitrary Frege Arithmetic

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The ways out of Russell's Paradox proposed so far does not precisely mirror a corresponding explanation of the origin of the contradiction and often imply a weakening of the hoped strength of the theory (cf. [4], [5], [3]); regarding the issue of logicality, an undesired dilemma overshadows the abovementioned results: precisely in case of logical (i.e. permutation invariant) abstraction principles, their implicit definienda turn out to be non logical ([1]) – so preventing a full achievement of Logicist goal. My preliminary aim consists in arguing that these, apparent unrelated, problems have a common source in some unquestioned assumptions of Freges' project. I argue that such assumptions are part of what we can call the Traditional view of abstraction, that includes the choice of classical logic as the base theory, with the related semantical consequence of full referentiality of the vocabulary, and the choice of a so-called Canonical interpretation function for all the expressions of the language. In the rest of the talk, I show that by renouncing to one or both of these problematic assumptions we can recover consistency and/or logicality. I propose a double revision of Frege's Logicist program: on the one side, weakening Canonical interpretation function for the implicitly defined (abstract) expressions of the vocabulary (cf. [2]), I prove that any consistent revision of BLV turns out to be logical (i.e. permutation invariant); on the other side, I show that such an arbitrary interpretation, on a (negative) free logic background, allows us to identify a restriction of BLV, able to precisely exclude the paradoxical concepts, namely to avoid Russell's Paradox, but, at the same time, to preserve the derivational strength necessary to derive second-order Peano axioms. This means that this system (Arbitrary Logicism), precisely renouncing to the Traditional assumptions mentioned above, is able to recover both Frege's goals of consistency and logicality.

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On Benardete's Paradox via Representation in Classical Mechanics

AMAIA CORRAL-VILLATE
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The paradox analysed in my talk was introduced by Benardete (1964) in the context of his metaphysical problems of the infinite. Yablo (2000) concluded that the paradox contains a logical impossibility, but reasonings introduced by Hawthorne (2000) and Uzquiano (2012) imply the questioning of this idea. Contextualised in this discussion, the objective of my talk is to use the analytical power of classical mechanics to deepen in the understanding of the paradox, by introducing a representation in the strict context of this theory. The results of my mechanical analysis lead to conclude that the problem that underlies the paradox is not logical but causal, and are thus in clear opposition to the reasoning defended by Yablo (2000). Additionally, they show that in spite of being in agreement with their causal view of the paradox, the violation of the change principle introduced by Hawthorne (2000) is not a big metaphysical surprise but a simple and direct consequence of causal postulates implicit in classical mechanics, and that the necessary condition that Uzquiano (2012) proposes for the existence of a before-effect is refutable.

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On the Defence of the Epistemic Value of Contradictory Premises in Scientific Theories

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In the past century, a number of quantum logics ($\mathcal{QL}$s) emerged from philosophically grounded non-classical semantics. $\mathcal{QL}$s primarily focused on modeling inferential processes relevant to physics, which is what quantum propositions traditionally formalize. Formally, however, $\mathcal{QL}$s may just be viewed as non-classical logics, similar to those that arise as logical counterparts of algebraic structures defined by equational axioms weaker or alternative to those of Boolean algebras. Such structures (e.g. orthomodular lattices) can be introduced in a standard first-order logic setting by axioms (e.g. orthomodularity) that are not specific to quantum physics. This approach is agnostic to the content of quantum propositions, so the "quantum" denomination remains only for historical reasons. The approach outlined above avoids certain philosophical difficulties regarding, e.g., the epistemological status of logic itself [1], or the comparison between $\mathcal{QL}$s and classical applied mathematics [4]. It also seems appealing if we consider that the mathematical formalism of quantum mechanics –but not $\mathcal{QL}$s as yet– has been successfully applied for a number of non-physical purposes, including modeling inferential processes in human cognition [3]. Given the relation of $\mathcal{QL}$s to this mathematical formalism, we argue that this makes a philosophically relevant case for applying $\mathcal{QL}$s outside of the traditional domain of physics. Viewing these logics from a meta-mathematical standpoint can provide new and interesting insights into the philosophy of quantum information theory [2]. Moreover, it can make logic viable again as a tool to formalize inferential processes in settings where classical logical formalizations are known to be inadequate. We are currently investigating the potential of $\mathcal{QL}$s in this regard by formalizing the results of cognitive xperiments on categorization [5].

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On the Defence of the Epistemic Value of Contradictory Premises in Scientific Theories

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The scientific discourse is filled with examples of theories with contradictory accounts about phenomena, such as the electron theory of the atom, the infinitesimal number in derivatives, and the initial singularity. But in the philosophy of science, there is still controversy about the nature and epistemic value of these inconsistent accounts. On the one hand, whether they exist as real entities or they should be relegated to mere fictional, even meaningless, objects; On the other hand, whether any knowledge gained from these contradictory propositions is accidental, or instead, they are a substantial part of a theory. In this session, I will discuss the latter epistemic question, and I will argue for the epistemic value of contradictory accounts in three steps. First, I will illustrate different ways in which scientific theories seem to gain a higher degree of credence by incorporating some beliefs expressed by incompatible accounts. Second, I will review the positions by which inconsistent phenomena form epistemic possibilities within a theory, and their vulnerabilities. Finally, I will reject the role of paraconsistent systems of logic in achieving the goals of this argument.

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Formal Epistemology and Conspiracy Theories

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There *is*, it turns out, a theory in formal epistemology that does not uphold the Entailment Principle, and isn't caught off-guard by possibility raising. Maybe its wheels will stay on if we take it for a ride! It's often ignored or quickly dismissed with some standard "counterexamples" that really aren't counterexamples at all. The theory is Dempster-Shafer Theory. Interestingly, it yields Bayesian updating as a special case. The circumstances that would make Bayesian updating proper, however, are circumstances that never are satisified for real flesh-and-blood humans. The beauty of Dempster-Shafer Theory (DST) is that it has something to offer to those of use who fall short of Bayesian ideals when it comes to our credence distributions (i.e., all of us). It does not demand that we start with all the finest-grained possibilities in view, and it does not demand that our belief distribution is a full function from the finest grained possibilities that are in view to credence values. It instead envisions a belief distribution which distributes total belief "mass" across the power set of the possibilities that are in view. This might sound obscure, but it's not; I'll show that flesh-and-blood humans do it all the time.

DST might not be the cure to all that epistemically ails us, but I'll argue that it has more promise than Bayesianism when we take it out on the road and run into conspiracy theories.

Heaps to Facts: Frege's Long Argument

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An attentive reader of Frege's "Über Sinn und Bedeutung" must be struck by his decision to disregard facts (consisting of objects, properties, and relations) as truthmakers of true thoughts and 'Bedeutungen' of sentences that express them, and to propose instead that thoughts are true because, in one way or another, they present the same object – the True (false thoughts, the False). But what happened with facts, the things we typically take to be the target of our declarative sentences and thoughts such sentences express? If sentences and thoughts (sometimes) concern facts, and if these sentences and thoughts are true whenever facts obtain, would it not be natural to identify precisely such entities with truthmakers of thoughts?

Many philosophers before Frege and after him thought precisely that; Frege thought that reasons to believe otherwise are overwhelming and proposed instead to assign the role of facts to truth values. What reasons Frege might have had for this? In my presentation, I will explain Frege's curious move and analyse the arguments he offered to support it. I will identify crucial places in Frege's writing where he attacks facts and show that the same pattern of argumentation occurs in each of the places, starting with the 1884 criticism of Mill in *Grundlagen* up to the criticism of the manuscript of Wittgenstein's *Tractatus* in 1919.

A New Philosophical Foundation of Constructive Mathematics

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Present paper examines the debate on the foundations of constructive mathematics. In particular it examines the current definition of Constructive mathematics as "mathematics within intuitionist logic" [1-4] This definition ignores two fundamental issues. First, it ignores the kind of organization of the theory at issue. I show that the use of intuitionist logic implies a problem-based organization, whose model is alternative to that of the deductive-axiomatic model, governed by classical logic [5]. Second, ignores that traditionally constructive mathematics was founded on (almost) only potential infinity instead of the free use of actual infinity, on which classical mathematics is founded. This well-known dichotomy is independent from the previous dichotomy on the two kinds of theoretical organization. According to this view on the foundations of mathematics as constituted by two dichotomies, a mathematical theory is based on the choices taken on these two dichotomies. As an example of this kind of foundation, arithmetic is rationally re-founded on both the model of the problem-based organization and constructive mathematical tools. As a consequence, a new definition of Constructive mathematics is suggested; i) it is mathematics making use of constructive tools and ii) it is organized in order to solve a basic problem with a new method discovered by reasoning within intuitionist logic.

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Filling the Gaps: Uses of Modal Logic in Historical Sciences

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Our knowledge of the past is inherently incomplete and requires operations to fill its gaps. Historians, in particular, employ imagination and counterfactuals in cases where traces, clues, and documents are insufficient for the development of historiography. What exactly are these operations of imagination and construction of counterfactual scenarios?

To account for these operations, I propose to analyse the use of modalities in the historical sciences using the semantics of possible worlds (Lewis, 1973; Stalnaker, 1968). This position corresponds with recent philosophical theories of imagination, particularly the "imagination under constraint"(Kind & Kung, 2016), for which Berto (2023) gives an adequate logic. I will argue that Berto's proposition can only partially give an account of imagination and counterfactuals in the historical sciences.

Throughout my paper, I will demonstrate 1) that counterfactuals and imagination as presented in Berto's work allow us to account for one particular historiographical tradition, namely "Counterfactual History" (Ferguson, 1999). 2) That Berto's logic can't account for certain kinds of historical conditionals; especially when we know the consequent, and we are trying to establish the antecedent. 3) That historical inferences could be understood within the framework of possible worlds.

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Conditionals, Counterfactuals and Imaged Belief Functions

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The present paper investigates the probability of counterfactuals and their associated updating procedures using a recent characterization established in [1] that combines Dempster-Shafer belief functions [2,3] with probabilities of modal conditionals. This characterization represents the probability of a counterfactual being true, $P(A \;\square\!\!\rightarrow B)$, as the value given to the consequent B by a belief function imaged upon the antecedent A.

Such result hinges upon Lewis-Gärdenfors notion of imaging and upon Dubois and Prades proposal in to extend imaging to the context of belief functions.

While the literature lacks a comprehensive account of imaging-type pro cedures beyond Bayesian settings, our work addresses this gap by exploring novel classes of imaged belief functions and their connections to counterfactuals. Specifically, we leverage the established characterization to explore how properties of Lewisian models for counterfactuals induce specific properties on the corresponding imaged belief functions. These investigation sets the ground for a structured taxonomy for understanding and representing imaging-type updating methods using Lewis counterfactuals and the results in [1].

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Modal Quantiers, Potential Innity, and Yablo sequences

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When properly arithmetized, Yablo's paradox results in a set of formulas which turns out to be consistent, but ω-inconsistent. Only adding either uniform disquotation or the ω-rule results in inconsistency. Since the paradox involves an innite sequence of sentences, one might think that it doesn't arise in nitary contexts. It turns out that the issue depends on how the nitistic approach is formalized. On one of them, explicating the metaphysical distinction between potential and actual innity, all the paradoxical sentences simply fail to hold. This happens at a price: the underlying nitistic arithmetic itself is ω-inconsistent. Finally, when studied in the context of a nitistic approach which preserves the truth of standard arithmetic, the paradox strikes back it does so with double force, for now the inconsistency can be obtained without the use of uniform disquotation or the ω-rule, but merely via modal interpretation of quantiers. In the talk I will sketch the formal results and discuss the metaphysical and semantic aspects of the formal model of potential innity involved. We believe the relevance of the talk with respect to the conference topics is two-fold: rst, it is an example of use of formal methods in the analysis of semantic paradox, and second, by the discussion of the distinction between potentialism and actualism in philosophy of innity, it demonstrates the use of mathematical logic in metaphysics.

Elimination Counterexamples: A Blow to Accuracy Monism?

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One of the most prominent research programs in philosophical analysis of scientic methods in recent years has been the so called accuracy-rst epistemology, according to which the usual tools used to assess the accuracy of the degrees of belief are scoring rules functions that measure the quality of a probability-estimate for a given event, with lower scores signifying probabilities that are closer to the event's status (1 if it occurs, 0 otherwise). Which of the rules should we choose? It has

been argued that the Brier Score (a.k.a. the quadratic scoring rule), at least in the partition version, is not a good tool for measuring the value of an agent's belief function. The reason is that Bayesian conditionalization is supposedly always of epistemic benet to the agent, yet there are cases in which, according to the Brier Score, the inaccuracy of a belief function increases after conditionalization. In this work, we study those situations where an agent's epistemic state, presumably, improves, and yet its inaccuracy increases, in more detail. We show that the phenomenon is, in a precise sense, frequent, and that it plagues more inaccuracy measures than hitherto known. Lastly, we investigate how this fact can be used as an argument against veritism.

To Oblige and To Be Obliged: an Analysis of Two Deontic Notions

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Formal approaches usually ignore the impact of imperatives on the obligations and permissions of the receiving agents (as in [1], although there are some exceptions like [2]) or how preexisting obligations could limit the normative ability of the issuer to emit imperatives. A class of models is presented in this talk, taking imperatives as announcements that modify the obligations agents have. This requires a previous explanation of how obligations and permissions could be ascribed to agents in one initial setting; and how new obligations and permissions could arise as a consequence of two operations enlarging or shrinking the set of such obligations and permissions. This way, imperatives uttered by agents can be defined in terms of both operations and the changes of obligations they provoke for their subordinates.

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Checking and Balancing Robot Judges: Formal Philosophers as Political Authorities

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As a political authority, AI that partakes in the exercise of judicial power (e.g., the so-called robot judges) should be checked and balanced so as to avoid any abuse of power. Part of such checking and balancing should be the evaluation of whether the justifications provided by the said AI are aligned towards the epistemic value of foreseeability and the legal value of legality. This imposes certain normative operational requirements to the logical form of those justifications. It is formal philosophers that are equipped with the expertise to identify such requirements and to evaluate their implementation.

In my presentation, I will provide real-life examples of such formal-philosophy challenges in the context of philosophy of interdisciplinary. I will further exhibit how the conceptual re-engineering methodologies of Carnapian explication and Dworkinian narrow reflective equilibrium can be merged into one coherent methodology to address those challenges. I will apply the proposed methodology to robot judges that causally justify judgements of the European Court of Human Rights. Finally, I will explore ways of checking and balancing formal philosophers since they now constitute political authorities themselves.

Is a Realist Spin on Spin Realistic?

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In his (2019) monograph, Darrell Rowbottom develops and defends a revitalized version of instrumentalism. As part of his defense, he argues that his position fits better with the development of atomic theory between 1885 and 1930 than pre-existing realist and anti-realist alternatives. I contend that when contextualized with the subsequent development of new quantum theory, the historical episode actually fits better as part of a defense of scientific realism. Specifically, since the Bohr-Sommerfeld model is equivalent to the first-order perturbation of new quantum theory, it need not be construed as merely instrumental. Moreover, this perturbation-theoretic perspective on the historical episode directly accords with William Harper's (2011) realist explication of Newton's ideal of empirical success.

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Russell, Definite Descriptions and Anselm's God

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We examine the relationship between the ontological argument, in its original version provided by Anselm in Proslogion II, and the Russellian theory of definite descriptions. The prevailing approach to formalization of ontological arguments is based on the application of modal logic, as in the works of Malcolm, Hartshorne, or Plantinga. Following Barnes, and Oppenheimer, and Zalta, we take as our basic assumption that the proper analysis of the ontological argument from Proslogion II should use some logic of definite descriptions, since the crucial elements of this argument are based on the definite description characterizing God according to Anselm. In fact, several theories of definite descriptions were developed and we will be interested in the problem of which of them is the most suitable tool for formalisation and evaluation of the ontological argument. Our considerations conclude that only the Russellian logic of descriptions, and closely related negative free logic, allows us to validate the ontological argument.

Bisequent Calculi for Definite Descriptions in Neutral Free Logic

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We present a bisequent calculus (BSC) in the spirit of [1] for the minimal theory of definite descriptions (DD) based on Lambert's axiom in the setting of neutral free logic, where formulae with non-denoting terms take the third truth value. The treatment of quantifiers, atomic formulae and simple terms is based on the approach developed by Pavlović and Gratzl [2]. We extend their results to the version with identity and definite descriptions. In particular, soundness, completeness, and the admissibility of cut are proven for this extended system.

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What Arguments in the Reduction-Emergence and Individualism-Holism Debates Are 'Strong'? Towards a Rigorous and Relevant: Definition Informed by Computational Complexity

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Reduction-emergence and individualism-holism debates in the philosophy of natural and social sciences loosely label arguments as 'weak', 'in practice', 'merely epistemological' if they refer to the practice of actual or possible science by any cognitive agents in a physical world and 'strong', 'in principle', 'ontological' or 'metaphysical' even if they hold only mathematically, unbound by physical constraints. It is confused and irrelevant to science and philosophy thereof.

I suggest an alternative informed by the asymptotic computational com- plexity and asymmetry of complexity classes of reductivist and emergentist epistemic procedures. Using Conway's Game of Life as a formal model for philosophical experiments, I show how the time and space resources needed for reductivist explanation of social by individual, mental by physical, chemical by physical might grow unfeasibly with the size of the phenomena studied. While emergentist approaches use computationally lighter empirical identification and higher-level causation. I suggest the computability and feasibility of epistemic procedures in a physical world as a hallmark of the relevance and strength of philosophical arguments.

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Temporal Logic of a Monad in Topological Ontology

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For the ontological description of the world, Leibniz proposed the concept of a monad (Leibniz Monadology). A monad is a simple object, and therefore undecomposable, but one of which complex things are composed (Point 1 and 2 of Monadology). The monad, although simple, contains qualities, properties (Point 8), perceptions and the so-called appetition (Points 10 - 15), i.e. the ability to pass from one perception to another (to others). The monad also creates its knowledge of the world according to its capacities (Points 60 - 62).

As part of my ontological research, I tackled the problem of formalizing the monad in the language of topological ontology, i.e. such an ontology that makes use of the concepts, theorems and tools of general topology. It turned out that the monad, although a simple object, should be understood as a five-element system M in which we find: the topological space, the duration of the monad, the tools for passing from one perception to another and also conceptual and propositional perceptions. Formally:

DEFINITION. A monad M is an 5-th tuple $((P, T(P)), I_{\langle b,d \rangle}, OP_M, AP_M, CP_M)$, where $(P, T(P))$ is a topological space on some set of elementary perceptions P, $I_{\langle b,d \rangle}$ is a period established for M, OP_M is its set of operations, AP_M its appetition and CP_M the collection of compound perceptions determined by appetition of M.

This conception of the monad (it is a formal conception) raises the question of how knowledge of the world is created: the knowledge of the individual monad. It also raises the question of the logical account of this knowledge that the monad has from the time of its creation to the time of its annihilation. And hence the problem arises: does the monad follow a certain logic which, as a temporal object, can be described using temporal logic? I will test the hypothesis with which the answer to the last question is positive.

If so, it is possible to create a temporal logic for the monad. I will show how such a logic can be constructed, depending on how the duration of the monad is understood. It will turn out that a monad, based on propositional perceptions i.e. simple and complex sentences, can realise a basic temporal logic, but also one that satisfies the axioms of Cocchiarella's, Scott's or Prior's. If God is also a

monad, then in this case we will consider its duration as infinite. I will also give the philosophical (ontological) consequences of the temporal logics considered.

From pre-Structuralism to Interdisciplinary Linguistics: The Development of Scientific Methods in Linguistic Research from Philosophical Perspective

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This study investigates the scientific debates on the nature of language, its evolutionary origins, and the identification of its users. It explores the historical development of linguistic scientific methodology, beginning with fieldwork linguistics and examining emergent developments in the context of neural language models. A key debate in linguistics is whether language is an innate faculty unique to humans (generativist view), which assumes the human mind/brain to have an inborn quality such as universal grammar or an acquired function resulting from exposure to linguistic data (usage-based view) which claims that language acquisition is a learning from corpus process. This study explores the implications of artificial intelligence advancements, where language models demonstrate humanlike language usage, providing evidence for usage-based theories. However, the counterargument of innatism is still criticizing the capacities of neural models' language understanding and production. Thus, this situation leads to real debates on language nature within the philosophy of science, in particular, the philosophy of linguistics. The study highlights the importance of establishing a robust connection between linguistics, cognitive science, and artificial intelligence to advance our understanding of key questions of the philosophy of science regarding language.

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The Role of Objectivity in the Foundations of Logic: Some Perspectives of the Beginnings of Modern Logic

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Starting from the concepts (ontological, formal and epistemological) of objectivity in the forerunners of modern logic (Leibniz, Kant, Bolzano) and from their respective methodological approaches (algebraic, aprioristic-intensional, extensional), we focus on the interplay of these aspects in some relatively neglected sections in the historical beginnings of modern logic.

The interplay of various sides of the logical concept of objectivity is illustrated using the example of the logic textbook by Robert von Zimmermann (1st ed., 1853 [5]). Furthermore, we particularly focus on Jevons-Clifford problem of types and the representatives of types of Boolean functions with n variables [1,2,3]. At the time, this was considered a fundamental logical problem (e.g., A. Nagy), and interest in it was later revived in the study of the structure and simplification of electric and computer circuits [4]. We examine the role of Jevons-Clifford problem in inductive inference, in the development of formal semantics and the theory of models (conceptually interconnected with Bolzano's method of variations), and in the emergence of specific logical methods: roots and structural properties of analytic tableaus and sequent calculus. We demonstrate the role of types of propositions in discovering primitive logical concepts. Special attention will be paid to the treatment and solution of the Jevons-Clifford problem in Albino Nagy and the context of his demarcation of logic from psychology and language.

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The Method of Socratic Proofs for Modal Logics: Inquiring and Justifying in the Realm of Modal Notions

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Conducting a formal proof is a particular example of scientific activity – a final act of justification of a truth found in the process of inquiry. On the other hand, the beginning of an inquiry is a problem to be solved, and these are expressed by questions, hence in a conceptual order questions must precede proofs in a very natural way. Also in time order, inquiry precedes justification.

In my presentation I will argue that inquiring and justifying are complementary cognitive processes, and as far as justifying can be captured and modelled by derivations and proofs in sequent calculi, inquiring can be captured and modelled by so-called *Socratic transformations* and *Socratic proofs* constructed in erotetic calculi. (See the first chapter of [1].)

There is also another idea how to view Socratic transformations and Socratic proofs: the idea of solving a problem by analyzing its logical structure – this is what logic does – and, in particular, of answering questions by "pure questioning", or by analyzing the logical structure of a question – which is what erotetic logic aims at. (See also [2–5].)

In my presentation I shall focus on erotetic calculi for the most recognizable normal modal logics (from K to S5). The rules of erotetic calculi are designed to transform questions – understood as expressions of certain formal language. At the same time, erotetic calculi constitute proof methods for the considered modal logics. I shall discuss basic concepts of erotetic calculi and its most important properties, like the fact that the calculi capture both local and global entailment relation.

Finally, going back to my initial idea that the processes of inquiring and justifying are *complementary*, I will also sketch a procedure establishing translation relation between erotetic calculi for the considered logics and sequent calculi for these logics.

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Logic of Absolute Necessity and its First-Order Extension

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The debate surrounding metaphysical and absolute (logical) necessities engages prominent figures like R. Carnap, D. Chalmers, K. Fine, B. Hale, P. Van Inwagen, S. Kripke, D. Lewis, G. Rosen, R. Stalnaker, T. Williamson, and others. There remains disagreement on whether metaphysical necessity aligns with absolute necessity, and defining their semantic distinction proves challenging. We propose to relativize the definition of absolute necessity to given logic: Δ is absolute necessity iff ΔA is satisfied in some model, then A is true in all possible worlds of all models, for any formula A of the language. We build logic with metaphysical necessity ($\mathsf{S5}$ for simplification) and absolute necessity (in the above-defined sense) that, as we show, is a proper extension of $\mathsf{S5}$. We develop a bimodal system as an axiomatic extension of W. Goranko and S. Passy's logic of universal modality, refining models to infinitary ones. We prove completeness by showing that the relations in the canonical frame defined on maximal consistent sets $wR_a u \iff \{A : \boxdot A \in w\} \subseteq u$ is universal, while the relation $wRu \iff \{A : \Box A \in w\} \subseteq u$ is an equivalence relation. Finally, we extend the $\boxdot$-fragment of the formalism to first-order logic, demonstrate its completeness, and compare its properties to Carnap's logic of logical necessity [1].

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Embodied Sensorimotor Hyperintensionality

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In this talk, I connect the concept of hyperintensionality from formal semantics to the study of sensorimotor agency in physical systems. A hyperintensional operator H is one such that HA and HB differ even when A and B are necessarily equivalent

[1]. I relate this concept to debates about the nature of representation that arise within 4E (embodied, embedded, enactive and extended) cognitive science. In particular, I apply a recent model of "semantic information"in physical systems [2] to a classically hyperintensional scenario (an arithmetic task), and argue

    a. that it serves as a useful model of the representational content of physical states, but

    b. that it fails to capture hyperintensional aspects of meaning, since it cannot distinguish between information about |X| and information about X2.

Building on these ideas, I propose a novel and distinctive notion of "embodied sensorimotor hyperintensionality" for physically embodied agents, which relates to the specific way in which correlations between internal and external variables contribute to task performance.

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A Dynamic Interpretation of Structural Causal Models

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Structural causal models [4] offer a popular, compact framework in which to model causal relations, and have recently been applied to a range of linguistic data, from conditionals [e.g. 5] to causatives [e.g., 3]. The widespread use of structural causal models raises the question: What, in the world, is a structural causal model? What does it mean in general for a structural causal model to be a true representation of a scenario? I seek to offer an interpretation of structural causal models, in the same sense in which we have interpretations of probability (Bayesian, frequentist) and interpretations of quantum mechanics (e.g. Copenhagen, many worlds): an attempt to explain how the formalism corresponds to experience. I propose that structural causal models are abstractions of dynamical systems. A structural causal model specifies how some parts of the world can and cannot change through time. I argue that this interpretation is more satisfactory than previous proposals based on agency [e.g., 1] and mechanisms [4, 2]. A further benefit of this interpretation is that it allows us to directly compare structural causal models with notion of circumstantial modality familiar to semanticists, such as Kratzer's (1977) analysis.

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On the Maximum of Positive Properties and Modal Collapse in Gödel's Ontological Argument Compared to its Variants

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Gödel's ontological proof of God - concluding from the logical level to the level of being - was strongly influenced by Leibniz' Monadology [1, p. 2], which is based on the Ur-Monade - God - that is conceived as absolutely infinite [2, p. 33]. Gödel defines God as the maximum of positive properties, which in turn represent the perfectives of being [3, p. 435], and he characterizes this maximum as an ultrafilter structure [4]. We have compared the set of positive properties in Scott's variant of Gödel's proof [5] with other variants to see whether this maximum is reached and what effect it has on modal collapse. The motivation for these variants was, among other things, to avoid modal collapse and an assumed limited determinism, for which changes were made to the axioms and thus to the (ultra-)filter structures of the underlying set of positive properties. Although the axioms now allow for multiple possible worlds, they now also allow for reduced sets of positive properties, so that God as the maximum is generally no longer obtained. Therefore, to reach the maximum, absolute infinity must be assumed, resulting in one absolutely infinite world, but without limited determinism.

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Composing Composers

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Inspired by a case from Ginsberg [2] concerning counterfactuals, Stalnaker [4] outlined the now famous "Composers" case which, if the "cautious" judgments concerning it are correct, causes serious trouble in epistemology: various theories of belief revision—e.g. AGM [1], as well as more recent theories from Leitgeb, Lin & Kelly, and Goodman & Salow—are false, as is the thesis that rational belief supervenes on rational credence (as Schultheis [3] observes). In contrast, the "bold" judgments regarding Composers cause no such trouble. All proposed models of Composers so far side exclusively with either the cautious or bold judgments. As Stalnaker [5] suggests, this is undesirable: *both* judgments seem reasonable, and which is to be preferred depends only on how epistemically bold the relevant agent is. I outline a new theory that can predict this permissive feature of Composers, while still maintaining a substantive connection between rational belief and credence.

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Calculus of Names with Czeżowski's Singular Sentences and Sentences for Identification

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In the paper, we will present an extension of the logic of categorical sentences with singular sentences by Tadeusz Czeżowski, having the form:

- This S is a P

- This S is not a P

where the letters 'S' and 'P' are replaced by non-empty general names. We present and analyze the results of Czeżowski. Moreover, we are building a calculus of names that is a conservative extension of Łukasiewicz's calculus of names by singular sentences.

Extending the calculus with singular sentences to include sentences for identifying indicated objects is interesting. These sentences take the form:

- This S is identical to this P

We give a set-theoretic semantics for the obtained calculus and prove a determination theorem with respect to this semantic.

A Certain Modification of the Theorem Concerning Independent Families and Expressions from the Algebra of Sets

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This presentation concerns an attempt to apply a certain (formal) method of justifying theorems known from the algebra of sets in the analysis of certain axiomatic conceptions occurring in philosophy. In order to accomplish this task, it is necessary to modify and justify the theorem that indicates this modified method. In the original approach [1, p. 21-22, 241-253], this method utilizes independent families of sets [2, p. 23] to identify the laws of the algebra of sets. On the other hand, using expressions from the algebra of sets, it is sometimes possible to formulate axioms which are supposed to capture certain philosophically significant concepts. An example of this can be the conceptions of genidentity, proposed by Zdzisław Augustynek [3]. The aim of this presentation is to answer the question

of whether it is possible to prove a theorem that is a modification of the theorem concerning independent families and expressions from the algebra of sets, in order to be able to determine on its basis which expressions are theses of the above-mentioned axiomatic conceptions occurring in philosophy. At the same time, this theorem indicates a family of sets that can be employed in this identification.

References:
[1] Guzicki W., Zakrzewski P. (2005), Lectures on an Introduction to Mathematics [in Polish: Wykłady ze wstępu do matematyki], Warszawa: Wydawnictwo Naukowe PWN.
[2] Kuratowski K., Mostowski A., Set Theory.With an Introduction to Descriptive Set Theory, Warszawa: Polish Scientific Publisher; Amsterdam, New York, Oxford: North-Holland Publishing Company.
[3] Porwolik M. (2017), The Axiomatic Approach to Genidentity According to Zdzisław Augustynek. Part I. The Comparision of Systems [in Polish: Aksjomatyczne ujęcia genidentyczności według Zdzisława Augustynka. Część I. Porównanie systemów], „Filozofia Nauki" 25(3) [99], 5–40.

Instrumental Devices

GEORG SCHIEMER
University of Vienna, Austria

A central theme in formal philosophy of the twentieth century was the study of purely instrumental uses of language in different fields. Roughly put, this is the focus on linguistic expressions that are viewed as formal or non-representational but nevertheless as indispensable or at least instrumentally useful for certain theoretical purposes. In the talk, I will present a general study of such instrumental devices and their logical properties as exemplified in three philosophical debates, namely (i) a formalist philosophy of mathematics inspired by Hilbert's program, (ii) the logic of science with a focus on theoretical languages in the so-called "syntactic view" of theories and (iii) a deflationist approach to axiomatic truth theories. In particular, I will evaluate different metatheoretic concepts used as adequacy conditions for the introduction of instrumental devices (such as mathematical terms, theoretical terms, or a truth predicate), namely syntactic and semantic versions of conservativity and relative interpretability. Given a presentation of these concepts and several metatheoretic results concerning them, I will survey how these formal notions are used in the three philosophical debates.

References:
[1] Detlefsen, M., (1986), *Hilbert's Program*, Dordrecht: Reidel.

[2] Halvorson, H., (2019), *The Logic in Philosophy of Science*, Cambridge: Cambridge University Press.
[3] Horsten, L. (2011). *The Tarskian Turn - Deflationism and Axiomatic Truth*, Cambridge: MIT Press.

Unification of Dependence

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University of Warsaw, Poland

Some believe that the aim of explanation is to understand why the world is the way it is. Some also believe that to achieve this aim is to reveal the dependence relation between explanandum and explanans (e.g., [4], [1]). In this sense, notions of causation, supervenience, grounding, existential/ontological dependence, etc., are considered explanatory, because each is an exemplification of the dependence relation. The explanatory role of this relation is a good reason to move attention to the notion of dependence. What might be an obstacle in the exploration of it is the variety of its types. Accordingly, while there is a plenitude of outstanding works dedicated to causation, supervenience, grounding, mereological/ontological dependence, etc., few consider the broader picture, i.e., the question of what these notions have in common. The aim of this paper is to address that question and to propose a general account of the dependence relation. The view is inspired by Humean supervenience and shows that acceptance of the so-called Best System Account ([2], [2], [5]) approach towards laws of nature makes it possible to picture the common feature of different dependence relations.

References:
[1] Kim, J. (1994). Explanatory knowledge and metaphysical dependence, *Philosophical Issues* 5:51-69.
[2] Lewis, D. (1973). *Counterfactuals*. Cambridge: Blackwell.
[3] Loewer, B. (1996). Humean Supervenience. *Philosophical Topics* 24 (1):101-127.
[4] Ruben, D.-H. (1990). Explanation in the Social Sciences: Singular Explanation and the Social Sciences. *Royal Institute of Philosophy Supplement* 27: 95–117.
[5] Schrenk, M. (2014). Better Best Systems and the Issue of CP-Laws. *Erkenntnis* 79 (S10):1787–1799.

On Tarski's System of Extended Mereology

GRZEGORZ SITEK

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The purpose of the talk is to present the extended system of mereology con- structed by A. Tarski and described in 'Appendix E' [1] to J. H. Woodger's book *The Axiomatic Method in Biology* [2]. In this book, Woodger proposed a formal system intended to capture the main concepts of biology. Among the primitive notions on which Woodger's system is based, were three relational concepts: the relational concept of "being a part of", the relational concept of "preceding in time" and the concept of "organized unit", the analysis of which was undertaken by A. Tarski in the aforementioned appendix. For this purpose, Tarski constructed a formal system in which he adopted an axiomatization of these concepts, which was alternative to Woodger's approach.

The talk will present the assumptions of Tarski's system and the most mportant theses. The construction of a model for the Tarski's theory will be discussed. Moreover, possible ways of further development of the Tarski's system will also be discussed - both those indicated directly by the author in his work, as well as those that go beyond the system he formulated.

References:
[1] Tarski, A. (1937). Appendix E, pages 161–172 in [2].
[2] Woodger, J. H. (1937). *The Axiomatic Method in Biology*. Cambridge, At the University Press.

Kant's Transcendental Object and the Concept of Limit

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In this presentation, I focus on the formal semantics proposed by Achourioti and Lambalgen Achourioti & Lambalgen (2011). The question is how does the use of the concept of limit allow us to understand Kant's notion of transcendental object. In order to find the answer, the broader question needs to be asked: what is the place of the concept of limit in Kantian epistemology? According to many contemporary readings (cf. Allison 2004, Hanna 2001, Longuenesse 1998) Kant's theory of judgement plays a crucial role in the argumentative structure of the First Critique. I argue that the concept of limit is implicit in Kant's definition of judgement via self-consciousness (B141-2). Apperception, seen only from the perspective of subordination relation of concepts, is the limit of the mind's self-determination activity and constitutes the transcendental object (Longuenesse 1998). In order to generalise this treatment to other than categorical judgement forms, a more abstract notion of limit indeed seems to be helpful. I analyse the

use of inverse limit in Achourioti & Lambalgen (2011) with focus on the interplay between 'unity of apperception' as directed set of indices and transcendental object (inverse limit). Remarks concerning the use of formal methods in philosophy and its dangers in history of philosophy (Hansson 2000, Novaes 2018) conclude the presentation.

The Fairness of Crowds: Crowds Beat Averages Laws for Algorithmic Fairness

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In many contexts of vital social importance, we care that predictions are not just accurate but also fair. In algorithmic forecasts of the risk of recidivism in the criminal justice system, for example, both accuracy and (racial, gender, etc.) fairness are crucial goals. That these goals can come apart is widely appreciated. It is also widely appreciated that averaging or pooling different forecasts can yield greater accuracy, which can be seen as a wisdom of the crowds effect. Can pooling yield greater fairness? I show that the linear pool of predictive algorithms is at least as fair as the average algorithm—for certain ways of gauging algorithmic fairness. This result does not hold for other popular fairness metrics or for other prominent ways of pooling. I detail some ramifications of these observations for the accuracy-fairness tradeoff, the algorithmic leviathan, and algorithmic fairness more generally.

Another Version of Gödel's Ontological Argument. Positiveness and Quantity of Reality

KORDULA ŚWIETORZECKA
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We start with the famous sketch "Ontologisher Beweis" from 1970 [3] and present another version of Gödel's ontological argument in which we introduce the relational concept of *being more perfect than* taken from Leibniz. The reference to Leibnizian metaphysics is justified by original Gödel's notes and the main structure of the derivations carried out in [3]. According to Leibniz, the so-called *perfections* attributed to the Absolute are *positive* and Gödel takes this idea: he uses the primitive predicate "is positive" predicated of properties and proves the necessary existence of the subject of all positive properties. Usually, it is supposed that $S5$ modalities are used. Leibniz, however, also gives in [4] the interpretation

of perfection similar to Anselm's idea in *Proslogion*. As he writes, due to the "quantity of reality" conveyed by the properties, they are compared as more or less perfect [4]. We follow this intuition and we link the concept of positiveness with the intensionally understood relationship of *being more perfect than*. We define the Absolute as the subject of all properties that are more perfect than all not-positive properties. We formulate a modal two-sorted theory in which we prove e.g. that all properties of the Absolute are positive and that each property necessarily implies identity property but identity is not more perfect than any positive property. We show a model for the resulting theory and compare it with a few other known versions of Gödel's argument (e. g. [2]).

References:
[1] Adams, R. M., (1995) Introductory note to *1970". In: S. Feferman et al. (eds.) *Kurt Gödel, Collected Works*, vol. 3, Oxford Univ. Press, 388–402.
[2] Anderson C. A., (1990). Some emendations of Gödel's ontological proof. *Faith and Philosophy*, 7: 291–303.
[3] Gödel K., (2002) Ontologischer Beweis. February 10th 1970. In: B. Buldt et al. (eds.) *Kurt Gödel. Wahrheit und Beweisbarkeit*, vol. II, Viena: ÖBV et HPT VerlagsgmbH and Co. KG, 307-–308.
[4] Leibniz, G.W. (1989). Letter to Arnold Eckhard (1677), In: L. E. Loemker (trans. and eds.) *Philosophical Papers and Letters*. The New Synthese Historical Library, vol. 2, Kluwer Academic Publ. 177–181.

The Problem of Context-Sensitivity for the Formal Theories of Belief-Credence Interaction

TAMAZ TOKHADZE
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In the past decade or so, new work in formal epistemology has provided novel and precise coherence principles between categorical beliefs and numerical credences (e.g., [3], [4]). Their aim is to combine logical norms on belief and probabilistic norms on credence into a plausible theory of how belief and credence should hang together. Focusing on Leitgeb's stability theory [3], this paper discusses a well-recognized problem of context sensitivity for such formal approaches. On these theories, you may rationally believe proposition X if you are only concerned with X; but if you want to consider X together with some other proposition(s), then believing X may no longer be rational. This paper aims to go beyond the simple context-sensitivity of such formal theories and provide a richer setting that allows us to articulate a more context-invariant and stable conception of belief. Starting with the idea that rational categorial belief simplifies and supports relia-

ble reasoning [2], I will motivate the thesis that contexts relevant to whether an agent believes X are the contexts that represent the causal or evidential structure of the agent's evidence concerning X. I will precisify and defend the thesis by using the tools from Bayesian network theory [1]. I'll conclude by discussing the implications of the defended view for the lottery paradox.

References:
[1] Fenton, N., & Neil, M. (2018). *Risk assessment and decision analysis with Bayesian networks.* Crc Press.
[2] Foley, R. (2009). Beliefs, Degrees of Belief, and the Lockean Thesis. In: F. Huber, C. Schmidt- Petri (eds.), *Degrees of Delief.* 37-47. Dordrecht: Springer.
[3] Leitgeb, H. (2017). *The Stability of Belief. How Rational Belief Coheres with Probability.* Oxford: Oxford University Press.
[4] Lin, H., & Kelly, K. T. (2021). Beliefs, Probabilities, and their Coherent Correspondence. In: I Douven (Ed.), *Lotteries, knowledge and Rational Belief: Essays on the Lottery*

A Solution to the Problem of the Meaning of 'meaning'

URSZULA WYBRANIEC- SKARDOWSKA
Cardinal Stefan Wyszyński University in Warsaw, Poland, Emeritus

The word 'meaning', itself lacking precision as regards its meaning, requires formal-logical explication. Searching for its precision has been and still is the goal of numerous attempts undertaken in the literature pertaining to philosophy and logic of language. There exist different philosophical conceptions concerning the nature of meaning and various theories of meaning, but none of them is a general theory of meaning as a semantic-pragmatic theory. The present work embarks on providing an answer to the question: What is the meaning of 'meaning'? The aim of the paper is to outline the foundations of a certain general, formal-logical theory of meaning and denotation which explicates these crucial notions of current general semantics and pragmatics. In the theory, according to the token-type distinction of Peirce, language is formalized as a creation of double ontological nature: first, at the token-level, as a language of tokens (understood as material, empirical objects, placed in time and space) and then, at the type-level, as a language of types (understood as abstract objects, as classes of tokens). The basic concepts of the theory, i.e. the notions meaning and denotation of well-formed expressions (wfes) of the language are defined at the type-level, however, by means of some primitive notions introduced on the token-level. The definition of the notion of meaning makes reference to the ideas of L. Wittgenstein and K. Ajdukiewicz, of treating the notion as a creation determined through the way of using

expression-type. The meaning of a wfe is defined as an equivalent class of the relation possessing the same manner of using wfe-types. In accordance with the well-known differentiations Sinn-Bedeutung of G. Frege and intension-extension of R. Carnap, the notion of denotation differs from that of meaning and, in the paper, is defined by means of the relation referring of wfe-types to objects of reality described by the given language.

Gödel's First Incompleteness Theorem as Function Composition

ANDREA VESTRUCCI
University of Bamberg, Germany

The paper encodes Gödel's first Incompleteness Theorem as a composition of functions. It expands upon [1] in offering a clearer proof presentation and an explicit link with Cantor's strategy. Our approach unfolds in the following steps: First step: diagonalization of a one-free-variable 10 formula in theory T. This is done by applying a 1010 matrix-building function, and then a function substituting the free variable in each 10 with the Gödel number of another 10. The matrix diagonal displays the diagonalization of each formula. Second step: fixed-point lemma. It is built first by mapping the diagonalized formulae 10 to the proof of their diagonalization, and then by applying to such proofs the same matrix-building and substitution functions. Again, the matrix diagonal displays the diagonalization of each proof. Last step: Gödel sentence. This is obtained by "flipping the diagonal" by mapping each diagonalized proof to the negation of the provability of this diagonalization. Thus we have $T\delta \leftrightarrow \neg\text{PROV}(\overline{[\delta]})$. The benefits of this encoding are several, e.g.: Logical: it refers to the (diagonalization of) proofs of diagonalizations of 10 formulae. Historical: it harks back to Cantor's diagonalization method in the proof. Didactic: the clarity of this encoding makes it a useful resource for educational purposes. Computational: this encoding enables a faithful implementation of the first Incompleteness Theorem in varieties of automated reasoning environments. *References:*

[1] Yanofsky, N. S. (2003). A universal approach to self-referential paradoxes, incompleteness, and fixed points. *Bulletin of Symbolic Logic*, 9.3: 362-386.

PROGRAMME

THURSDAY, PART 1, May 16, 2024

09:00-10:00	Registration	(Secretariat and registration desk)

10:00-10:10	Opening	

10:10-11:00	**Key-note lecture**: Maria MANZANO: My References on Logic Education
11:05 -11:45	Christoph BENZMÜLLER, David FUENMAYOR: The LogiKEy Methodology: Applications in AI Ethics and Prospects in Logic Teaching
Chair: K. Świętorzecka	(Large Hall, basement fl.)
11:45-12:15	*Coffee break*

Parallel sessions *F* and *G*:

(*F*) Chair: M. Novina		(Room F)
12.15-12:50	Anna BROŻEK: Moderate Reconstructionism as a Metaphilosophical Standpoint	
12:50-13:25	Duško DOŽUDIĆ: Heaps to Facts: Frege's Long Argument	
(*G*) Chair: M. Porwolik		(Room G)
12.15-12:50	Andrzej INDRZEJCZAK, Yaroslaw PETRUKHIN: Bisequent Calculi of Definite Descriptions in Neutral Free Logic	
12:50-13:25	Andrzej PIETRUSZCZAK: Calculus of Names with Czeżowski's Singular Sentences and Sentences for Identification	
13:30-14:30	*Lunch*	(Atrium)

The time slot for each lecture/talk includes 5–10 minutes for discussion.

THURSDAY AFTERNOON, May 16, 2024

15:10 -15:50 Yves BOUCHARD: Epistemic Type Mismach	
Chair: C. Benzmüller	(Large Hall, basement fl.)

Parallel sessions *F* and *G* (16:00–17:10):

(F) Chair: D. Leszczyńska-Jasion	(Room F)
16:00-16:35 Marek PORWOLIK: A Certain Modification of the Theorem Concerning Independent Families and Expressions From the Algebra of Sets	
16:35-17:10 Janusz KACZMAREK: Temporal Logic of a Monad in Topological Ontology	
(G) Chair: Y. Bouchard	(Room G)
16:00-16:35 Tamaz TOKHADZE: The Problem of Context-Sensitivity for the Formal Theories of Belief-Credence Interaction Described Using Common 3D Physics	
16:35-17:10 Tommaso FLAMMINIO, Lluis GODO, Giuliano ROSELLA: Conditionals, Counterfactuals and Imaged Belief Functions	
17:10-17:30 *Coffee break*	

Parallel sessions *F* and *G* (17:30–18:40):

(F) Chair: D. McHugh	(Room F)
17:30-18:05 Simon McGREGOR: Embodied Sensorimotor Hyperintensionality	
18:05-18:40 Theodore IZMAYLOV: What Arguments in the Reduction-Emergence and Individualism-Holism Debates Are 'Strong'? Towards a Rigorous and Relevant Definition Informed by Computational Complexity	
(G) Chair: T. Tokhadze	(Room G)
17:30-18:05 Jason DECKER: Formal Epistemology and Conspiracy Theories	
18:05-18:40 Maciej SENDŁAK: Unification of Dependence	

The time slot for each lecture/talk includes 5–10 minutes for discussion.

09:00-09:50	**Key-note lecture**: Peter GÄRDENFORS: How a Model of Event Cognition Can Be Applied to Causal Reasoning and Verb Semantics

09:55 -10:35	Georg SCHIEMER, Instrumental devices
Chair: S. Kovač	(Large Hall, basement fl.)
10:35-11:05	*Coffee break*

Parallel sessions *F* and *G* (11.05–12:50):

(*F*) Chair: A. Indrzejczak	(Room F)
11.05-11:40	Michał Tomasz GODZISZEWSKI, Leszek WROŃSKI, Zalan GYENIS: Elimination Counterexamples: A Blow to Accuracy Monism?
11:40-12:15	Victor ARANDA, María MANZANO, Manuel MARTINS: Splitting Truth in Hybrid First-Order Logic
12:15-12:50	Marcin ŁYCZAK: Logic of Absolute Necessity and its First-Order Extension
(*G*) Chair: G. Schiemer	(Room G)
11.05-11:40	Antonino DRAGO: A New Philosophical Foundation of Constructive Mathematics
11:40-12:15	Dean McHUGH: A Dynamic Interpretation of Structural Causal Models
12:15-12:50	Rush T. STEWART: The Fairness of Crowds: Crowds Beat Averages Laws for Algorithmic Fairness

The time slot for each lecture/talk includes 5–10 minutes for discussion.

FRIDAY AFTERNOON, May 17, 2024

15:00-15.50   **Key-note lecture**:
               Leon HORSTEN: Reflection in the Mathematical Sciences

Chair: A. Brożek   (Large Hall, basement fl.)

Parallel sessions *F* and *G* (16:00–17:25):

(*F*) Chair: M. Sendłak	(Room F)

16:00-16:35   Marina NOVINA: ??
16:35-17:00   Jeremy ATTARD: A Belief–Action Interaction Model for Social
               Epistemology
17:00-17:25   Fran CARDELLS: On the Defence of the Epistemic Nature of
               Contradiction

(*G*) Chair: A. Vestrucci	(Room G)

16:00-16:25   Cordelia MÜHLENBECK, Christoph BENZMÜLLER:
               The Maximum of Positive Properties and the Modal Collapse in
               Gödel's Ontological Proof of God in Comparison to Modified Proofs
16:25-16:50   Jakub SOCHACKI: Kant's Transcendental Object and
               the Concept of Limit
16:50-17:25   Srećko KOVAČ: The Role of Objectivity in the Foundations of
               Logic: Some Perspectives of the Beginnings of Modern Logic

17.25-17.45   *Coffe break*

Parallel sessions *F* and *G* (17:45–19:40):

(*F*) Chair: J. Attard	(Room F)

17:45-18:10   Joshua Edward PEARSON: Composing Composers
18:10-18:35   Evan IATROU: Checking Balancing Robot Judges: Formal
               Philosophers as Political Authorities
18:35-19:00   Rodrigo Mena GONZÁLEZ: To Oblige and To Be Obliged:
               An Analysis of Two Deontic Notions
19:00-19:25   Lucas ESCOBAR: Filling the Gaps: Uses of Modal Logic in
               Historical Sciences

(*G*) Chair: J. Sochacki	(Room G)

17:45-18:10   Jared IFLAND: Is a Realist Spin on Spin Realistic?
18:10-18:35   Amaia CORRAL-VILLATE: On Benardete´s Paradox via
               Representation in Classical Mechanics
18:35-19:00   José Alejandro FERNANDEZ CUESTA, Michele PIAZZA,
               Umberto RIVIECCO: Quantum Logics Outside Physics:
               Philosophical considerations

The time slot for each lecture/talk includes 5–10 minutes for discussion.

SATURDAY, May 18, 2024

09:00-09:50   **Key-note lecture**:
Valentin GORANKO: Logics for Strategic Reasoning about
Socially Cooperative Rational Agents

Chair: M. Łyczak   (Large Hall, basement fl.)

Parallel sessions *F* and *G* (10:00–11:10):

(F) Chair: S. Kovač	(Room F)
10.00-10:35 Ludovica CONTI: Arbitrary Frege Arithmetic	
10:35-11:10 Grzegorz SITEK: On Tarski's System of Extended Mereology	

(G) Chair: J. Petrukhin	(Room G)
10.00-10:35 Dorota LESZCZYŃSKA-JASION: The Method of Socratic Proofs for modal logics: Inquiring and Justifying in the Realm of Modal Notions	
10:35-11:10 Michał Tomasz GODZISZEWSKI, Rafał URBANIAK: Modal Quantifiers, Potential Infinity and Yablo Sequences	

11.10-11.30   *Coffee Break / or Farewell menu (+20min)??*

Parallel sessions *F* and *G* (11:30–+12:40 / 11:50-13:00?):

(F) Chair: V. Aranda	(Room F)
11:30-12:05 Kordula ŚWIĘTORZECKA: Another Version of Gödel's Ontological Argument: Positiveness and Quantity of Reality	
12:05-12:40 Andrea VESTRUCCI: Gödel's First Incompleteness Theorem as Function Composition	

(G) Chair: D. Dožudić	(Room G)
11:30-12:05 Urszula WYBRANIEC-SKARDOWSKA: A Solution to the Problem of the Meaning of 'meaning'	
12:05-12:40 Hassane KISSANE: From pre-Structuralism to Interdisciplinary Linguistics: The Development of Scientific Methods in Linguistic Research from Philosophical Perspective	

Chair: K. Świętorzecka	(Large Hall, basement fl.)
12:45-13:25 Andrzej INDRZEJCZAK: Russell, Definite Descriptions and	
13:05-13:45? Anselm's God: Approaches to Concepts	
13.25/13:45? *Closing*	

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