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SEVENTEENTH ASIAN LOGIC CONFERENCE AN OFFICIAL MEETING OF THE ASSOCIATION FOR SYMBOLIC LOGIC

Nankai University

Tianjin, China

October 9–13, 2023

The 17th Asian Logic Conference was held on October 9–13, 2023, in Tianjin, China. Organized by the School of Mathematical Sciences of Nankai University, the meeting took place at St. Regis Tianjin. It was the third Asian Logic Conference since its status changed from an ASL (Association for Symbolic Logic) sponsored meeting to an official ASL meeting by ASL Council action in May 2016.

The Asian Logic Conference (ALC) is a major international event in mathematical logic. It features the latest scientific developments in the fields in mathematical logic and its applications, logic in computer science, and philosophical logic. The ALC series also aims to promote mathematical logic in the Asia-Pacific region and to bring logicians together both from within Asia and elsewhere to exchange information and ideas.

Funding was provided by Nankai University, the National Natural Science Foundation of China, the Chinese Mathematical Society, the Tianjin Association for Science and Technology and the Association for Symbolic Logic.

The Program Committee consisted of Mohua Banerjee, Longyun Ding, Su Gao, Sergey S. Goncharov, Hirotaka Kikyo, Byunghan Kim, Keng Meng Ng, Andre Nies, Dilip Raghavan, Katsuhiko Sano, Keita Yokoyama (Chair), and Liang Yu.

The Local Organizing Committee consisted of Longyun Ding (Chair), Su Gao, Ming Xiao, Qihao Zhao and Cheng Peng.

There were nine plenary speakers:

William Johnson (Fudan University, China), *C-minimal fields are geometric.*

Bakh Khoussainov (University of Electronic Science and Technology, China), *Quasi-axiomatizability of algorithmically presented structures.*

Chris Lambie-Hanson (Czech Academy of Sciences, Czech Republic), *Set theory and derived functors of the inverse limit.*

Alexander Melnikov (Victoria University of Wellington, New Zealand), *Primitive recursive algebra, analysis, and combinatorics.*

Rizos Sklinos (Chinese Academy of Sciences, China), *Fields interpretable in nonabelian free groups.*

Slawomir Solecki (Cornell University, USA), *Descriptive set theory and generic measure preserving transformations.*

Liuzhen Wu (Chinese Academy of Sciences, China), *On the continuum function and strongly compact cardinals.*

Yue Yang (National University of Singapore, Singapore), *Computation beyond* ω.

Jinhe Ye (Oxford University, UK), *Lang-Weil type estimates in finite difference fields.*

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Special sessions on the following topics were held (speakers in parentheses): Computability theory (George Barmpalias, Jun Le Goh, Akitoshi Kawamura, Jiayi Liu), Model theory (Haosui Duanmu, Masato Fujita, Joonhee Kim, Chieu-Minh Tran), Philosophical logic (Bahram Assadian, Shawn Standefer, Yì N. Wáng, Ruizhi Yang), and Set theory (Ashutosh Kumar, David Schrittesser, Guozhen Shen, Xianghui Shi).

The program also included 13 contributed talks (20 minutes each). Abstracts of the invited talks and contributed talks given (in person or by title) by members of the Association for Symbolic Logic follow.

For the Organizing Committee
LONGYUN DING

Abstracts for Plenary Talks

► WILLIAM JOHNSON, *C-minimal fields are geometric.*
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One of the basic properties of o-minimal structures is that they are geometric, meaning that the model-theoretic algebraic closure operator has the exchange property. This condition has useful geometric consequences, such as a good dimension theory on definable sets. In the 1990's, Haskell, Macpherson, and Steinhorn found several variants of o-minimality, such as C-minimality and P-minimality. Just as real closed fields are the prototypical o-minimal structures, algebraically closed valued fields (ACVF) are the prototypical C-minimal structures and p-adic fields are the prototypical P-minimal structure. It is natural to ask whether the exchange property generalizes from o-minimal structures to C-minimal and P-minimal structures. Haskell, Macpherson, and Steinhorn showed that P-minimal structures have the exchange property, but C-minimal structures sometimes don't. Nevertheless, the question remained open of whether the exchange property holds in C-minimal fields, or equivalently, in C-minimal expansions of ACVF. We give a positive answer to this question.

► BAKH KHOUSSAINOV, *Quasi-axiomatizability of algorithmically presented structures.*
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We aim to describe the isomorphism types of algebraic structures in the language of first order logic. We define the notion of quasi-axiomatizablity that describes, in a precise sense, the isomorphism types of structures in first order logic. We focus on two classes of structures. The first is the class of structures for which positive atomic diagrams are computably enumerable. These structures are called positive structures. The second is the class of structures for which negative atomic diagrams are computably enumerable. These structures are called negative structures. Using expansions of languages, we investigate quasi-axiomatability of positive and negative structures by sets of $\forall$, $\exists$, $\exists\forall$, and $\forall\exists$-sentences.

► CHRIS LAMBIE-HANSON, *Set theory and derived functors of the inverse limit.*
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We will discuss some applications of set theoretic ideas to the study of the derived functors of the inverse limit functor. We will begin by presenting some now-classical theorems of Goblot and Mitchell from the early 1970s linking the vanishing of such derived functors to the cofinalities of the indexing posets before moving on to the late 1980s, when substantial

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set theoretic tools, including forcing, cardinal characteristics of the continuum, and the Open Coloring Axiom began to be applied to the study of the first derived functor of the inverse limit. We will then discuss a number of results from the last few years that have substantially improved our understanding of the higher derived functors of the inverse limit. We will conclude with some applications to questions coming from the study of strong homology and from condensed mathematics. This talk contains joint work with Jeffrey Bergfalk and Michael Hrušák.

► ALEXANDER MELNIKOV, *Primitive recursive algebra, analysis, and combinatorics.*
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In my talk, I will provide a comprehensive overview of recent advancements in the emerging field of primitive recursive, often referred to as 'punctual,' mathematics. The primary objective of this framework is to establish a robust theoretical foundation for a discipline situated between the abstract domains of computable algebra and constructive analysis, and various prevalent models of 'online' computation in combinatorics and computer science. This framework has yielded significant insights into the nature of unbounded search within many common broad classes of algebraic structures and separable spaces. The techniques employed in such results encompass a broad spectrum, ranging from degree-theoretic priority constructions to first-order definability with bounded quantification, as well as tools from reverse mathematics and proof theory in the style of Kohlenbach, Avigad and Feferman. Throughout the presentation, I will outline and discuss numerous results that even 'seasoned' experts in the audience may find counterintuitive.

► RIZOS SKLINOS, *Fields interpretable in nonabelian free groups.*
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After Kharlampovich-Myasnikov and Sela proved that nonabelian free groups share the same first-order theory, the model theoretic interest for the subject arose. A historically important question for any natural first-order theory is whether it interprets an infinite field or not.

In this talk, I will explain some of the principal ideas in proving that no infinite field is interpretable in the first-order theory of nonabelian free groups.

► SLAWOMIR SOLECKI, *Descriptive set theory and generic measure preserving transformations.*
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One of the areas of interest of Descriptive Set Theory is dynamics of Polish groups, that is, groups carrying a group topology that is separable and completely metrizable. Such groups are not, in general, locally compact. Therefore, in studying their dynamics, classical methods relying on Haar measure are not available. These methods can sometimes be replaced by descriptive set theoretic tools.

I will describe how the descriptive set theoretic point of view led to a recent answer to an old question in Ergodic Theory. The question lies within a long-established theme, going back to the work of Halmos and Rokhlin, of investigating generic measure preserving transformations. The answer to the question rests on an analysis of unitary

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representations of a certain non-locally compact Polish group that can be viewed as an infinite dimensional torus.

► LIUZHEN WU, *On the continuum function and strongly compact cardinals.*
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Large cardinals constrain the behavior of the continuum function. One well-studied topic is to determine the possible value of continuum function in presence of strongly compact cardinals. In this talk, we report some progress on the study of the possible behavior of continuum function on strongly compact cardinals.

► YUE YANG, *Computation beyond ω.*
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The notion of computable functions with domain ω, the set of natural numbers, is well understood by recursion theorists. Computation on domains beyond ω, for instance on real numbers, has also been well-studied. However, unlike on natural numbers, no consensus has been reached. Instead, various models with different motivations have been proposed.

In this talk, I will propose a notion of computability on higher type objects. The notion is based on earlier results on computation on real numbers or on Baire space, which were joint work with Keng Meng Ng from Nanyang Technological University, Singapore and Nazanin Tavana from Amirkabir University of Technology, Iran.

► JINHE YE, *Lang-Weil type estimates in finite difference fields.*
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A difference field is a field equipped with a given automorphism and a difference variety is the natural analogue of an algebraic varieties in this setting. Complex numbers with complex conjugation or finite fields with the Frobenius automorphism are natural examples of difference fields. For finite fields and varieties over them, the celebrated Lang-Weil estimate gives a universal estimate of number of rational points of varieties over finite fields in terms of several notions of the complexities of the given variety.

In this talk, we will discuss an analogue to Lang-Weil estimate for difference varieties in finite difference fields. The proof uses pseudofinite difference fields, where the automorphism is the nonstandard Frobenius. This is joint work with Martin Hils, Ehud Hrushovski and Tingxiang Zou.

Abstracts for the Special Session on Computability Theory

► GEORGE BARMPALIAS, *Randomness and reducibility.*
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The contrast between information and randomness can be formalized in terms of effective reducibilities and their properties on algorithmically complex oracles. I will present recent developments on this topic, and discuss their significance in the context of the algorithmic randomness of the last 20 years.

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► JUN LE GOH, *Reductions and (resolvable) combinatorial designs.*
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We report on ongoing work with Belanger and Dzhafarov. In our study of the computational strength of finite pigeonhole principles (in the Weihrauch lattice), we applied combinatorial results such as graph decomposition theorems and Turán's theorem in extremal graph theory. We then discovered that certain questions we were unable to resolve were in fact equivalent to longstanding open problems in combinatorics. We shall present such results, as well as results on the relationships between jumps of finite pigeonhole principles and well-studied problems in the Weihrauch lattice.

► AKITOSHI KAWAMURA, *Computational complexity of differential equations.*
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It has long been known that a simple differential equation given by a computable function can have non-computable solutions. Still, it seems that differential equations that are "well-behaved" or "arise in reality" tend to respect computability or even polynomial-time computability. In this talk, I will discuss some of our current knowledge about how the computational complexity of differential equations is affected by assumptions on the well-bahavedness of the input function or the setting of the problem.

► JIAYI LIU, *A combinatorial equivalence of a computability theory question.*
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We show that a question of Joe Miller, that whether computable variable word infinite instance admits computable solution, is equivalent to a combinatorial question. The positive answer of the combinatorial question turns out to be a generalization of Hales-Jewett theorem.

Abstracts for the Special Session on Model Theory

► HAOSUI DUANMU, *Nonstandard analysis and its application to general equilibrium theory.*
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Hara (2006) provided a counter-example on the existence of equilibrium in exchange economies with bads and a measure-theoretic space of agents. Noguchi & Zame (2006) established the existence of equilibrium with distributional externality on production economies with a measure-theoretic space of agents, but their proof depends on strong monotonicity of preferences and free-disposal in production, which are incompatible with the presence of bads. In this paper, we provide sufficient conditions for the existence of equilibrium in a measure-theoretic production economy with bads and externality on agents' preferences. Our model also sheds light on commonly used regulatory schemes such as quota and emissions tax.

The proof of our existence result depends heavily on nonstandard analysis. Given a standard measure-theoretic production economy, we construct a corresponding hyperfinite economy and hyperfinite Loeb economy. We extend agents' preferences in the original economy to preferences in the hyperfinite Loeb economy such that the standard part of the Loeb demand set is the demand set in the original economy. We then invoke the existence of equilibrium result from finite production economy to ensure the existence of equilibrium in the hyperfinite economy. We propose sufficient conditions to ensure S-integrability of the candidate equilibrium in the Loeb economy. Finally, we push down the equilibrium allocation

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in the Loeb economy to obtain an equilibrium in the original measure-theoretic production economy by taking standard part with respect to the weak topology.

► MASATO FUJITA, *On a few o-minimal-like structures.*
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In this talk, I will summarize the topological properties of sets definable in three 'o-minimal-like' structures; that is, definably complete locally o-minimal structures, uniformly locally o-minimal structures of the second kind and almost o-minimal structures.

Definably complete locally o-minimal structures enjoy tame topology and they have dimension functions satisfying van den Dries's requirements. In definably complete locally o-minimal structures, definable sets are decomposed into finitely many good-shaped definable sets called quasi-special submanifolds, but they are not necessarily locally partitioned into finitely many cells.

A natural question is in which structure definable sets are locally partitioned into finitely many cells. The answer to this question is uniformly locally o-minimal structures of the second kind. Almost o-minimality is a promising abstraction of locally o-minimal expansions of the ordered set of reals. In these three structures, several variations of decomposition theorem were proven.

I will also discuss similarity and difference among them in the talk.

► JOONHEE KIM, *Kim-dividing in NATP theories.*
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We discuss the relationship between dividing and Morley sequences in model theory and introduce some recent results: in NATP, over models, Kim-dividing is always witnessed by a coheir Morley sequence. We present some corollaries that follow from this. This is joint work with Hyoyoon Lee.

► CHIEU-MINH TRAN, *Measure doubling of small sets in SO(3,*$\mathbb{R}$*).*
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In a recent work, we show that if A is an open subset of $\mathrm{SO}(3,\mathbb{R})$ with sufficiently small normalized Haar measure, then $\mu(A^2) > 3.99\mu(A)$.

This was conjectured by Emmanuel Breuillard and Ben Green around 15 years ago in the context of getting optimal bounds and finding continuous counterparts of product theorems by Helfgott, Pyber-Szabo, and Breuillard-Green-Tao. The result is also related to the Brunn-Minkowski inequalities from convex geometry, the Kunze-Stein phenomenon from harmonic analysis, and the Pillay conjectures from model theory.

In this talk, I will explain these connections and discuss some ideas from the proof, which uses nonstandard analysis and neostable group theory. (The talk is based on joint work with Yifan Jing and Ruixiang Zhang.)

Abstracts for the Special Session on Set Theory

► ASHUTOSH KUMAR, *Some problems on Turing independence.*
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We will discuss some problems of the following type: Given a large set of reals, must it contain a large Turing independent subset? Here largeness will be interpreted in the sense

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of cardinality, measure as well as (Baire) category. Most of the results are joint work with Saharon Shelah.

► DAVID SCHRITTESSER, *Mad families and other maximal discrete sets.*
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Many interesting combinatorial objects in set theory can be subsumed under the idea of "maximal discrete sets". Classical examples are the well-studied mad families. This talk will review some recent developments as well as some open questions in this area.

► GUOZHEN SHEN, *A finite-to-one function from the symmetric group of an infinite set A onto A.*
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Using a special kind of Birkhoff lattices, we construct a permutation model in which there exists a finite-to-one function from the symmetric group of an infinite set A onto A, which cannot exist even in the presence of the axiom of countable choice. This is a joint work with Jiachen Yuan.

► XIANGHUI SHI, *Ramsey type theorems for trees, nonstandard proof and a new theorem.*
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We recently discussed nonstandard proofs for a series of Ramsey type theorem for trees, including Ramsey theorem for trees, Halpern–Läuchli Theorem and Milliken's Tree Theorem, in my graduate student seminar. The nonstandard treatment of these results led to the discovery of a new theorem that generalizes Halpern–Läuchli. In this talk, I will discuss these nonstandard arguments.

Abstracts for the Special Session on Philosophical Logic

► BAHRAM ASSADIAN, *Abstractionism and free logic.*
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According to abstractionism, Frege-style abstraction principles underwrite our knowledge of the existence of abstract objects such as numbers and classes. It is sometimes assumed that the abstractionist proof of the existence of such objects requires negative free logic (NFL). I show that there is a particular system of positive free logic (PFL) in which the proof goes through. Although this proof has limitations that do not arise in its NFL-counterpart, there is no indispensable need to use NFL. I offer a distinctively abstractionist motivation for the use of NFL. The usual motivation rests on the explanation of truth in terms of sub-sentential reference. Since this line of thought is not available in the context of the abstractionist proof, I offer a novel motivation that reverses the direction of explanation.

► SHAWN STANDEFER, *Extensionality in non-classical logics.*
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Equivalence is an important concept in logic, and there are many ways for claims to be equivalent. Extensionality is one prominent and useful sense of equivalence. In classical logic, it marks out a distinction between the truth-functional connectives and standard modal

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operators, for example. In this paper, we distinguish three forms of extensionality for formula contexts that can arise in non-classical logics. Looking at some prominent philosophical logics, we identify ways in these forms come apart. We close with some potential upshots for the related concepts of intensionality and hyperintensionality. Time permitting, we will draw out some lessons for set-theoretic extensionality principles in non-classical logics.

► YÌ N. WÁNG, *Epistemic Logics over Weighted Models: Proof Systems and Computational Complexity.*
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We study epistemic logics interpreted through similarity models based on weighted graphs. Besides the basic logics, we shall focus on extensions with modalities of common, distributed, and mutual knowledge. The concept of individual knowledge is redefined under these similarity models, which is no longer just a matter of personal knowledge, but is now enriched and understood as knowledge under the individual's epistemic ability. Common knowledge is presented as higher-order knowledge that is universally known to any degree, a definition that aligns with existing literature. We reframe distributed knowledge as a form of knowledge acquired by collectively leveraging the abilities of a group of agents. In contrast, mutual knowledge is defined as the knowledge obtained through the shared abilities of a group. We then focus on the resulting logics, examining their relative expressivity, semantic correspondence to the classical epistemic logic, proof systems and the computational complexity associated with the model checking problem and the satisfiability/validity problem. The talk is based on joint work with Xiaolong Liang.

► RUIZHI YANG, *How set-theoretic multiverse view matters?*
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The set-theoretic multiverse view is a relatively new trend in the philosophy of set theory and mathematics. This view is inspired by forcing and other model-generating methods that are commonly used in set theory research. It is intensively promoted and discussed by set theorists such as Joel D. Hamkins, John Steel, and philosophers such as Penelope Maddy or Neil Barton since the 2010's. Apart from the true or false question on those provocative claims made by multiverse view advocates, we wonder if this philosophical standpoint really matters. Is it a new view in philosophy of mathematics after all? How would mathematicians find this view relevant? In this talk, I want to exam how set-theoretic multiverse view matters. We start from the very basic question 'How philosophy of mathematics matters?' and try to extract clues to help answer the question.

Abstracts for Contributed Talks

► JINHOO AHN, JOONHEE KIM, HYOYOON LEE AND JUNGUK LEE, *Preservation and examples of NATP theories.*
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After JinHoo Ahn and Joonhee Kim have defined the antichain tree property (ATP) in 2021, some nice properties of theories without ATP (i.e. NATP theories), which are analogous to properties of theories without other model-theoretic tree properties [2] were observed by the same authors and Junguk Lee [1]. In this talk, we aim to see some preservation theorems of NATP theories, and use them to obtain several proper examples of NATP theories having TP_2 and SOP simultaneously. Especially, the parametrization and sum of the theories of Fraïssé limits of Fraïssé classes satisfying strong amalgamation property (SAP) will be considered. If time permits, we will also take a look at other preservation theorems and examples of NATP theories.

[1] JinHoo Ahn, Joonhee Kim and Junguk Lee, *On the antichain tree property*, ***Journal of Mathematical Logic***, vol. 23 (2023), no. 2, 2250021, 36 pages.

[2] Artem Chernikov and Nicholas Ramsey, *On model-theoretic tree properties*, ***Journal of Mathematical Logic***, vol. 16 (2016), no. 2, 1650009, 41 pages.

► HUAYU GUO AND BRUNO BENTZEN, *Martin-Löf's distinction between sense and reference.*

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The traditional distinction between sense and reference proposed by Frege faces a difficult challenge when viewed through the lens of constructive semantics. There is a growing interest in this topic since Dummett [1] first claims that the sense of an expression is related to its reference as a program to its execution. Dummett [2] elaborates on his own views with an explicit constructive background decades later, and his ideas are then further refined by Martin-Löf [3] in the setting of his own constructive type theory that explains computation as evaluation. Both papers remained unpublished for over twenty years until recently, but discussions in the literature are still lacking.

Some of the main novelties of Martin-Löf's distinction are the theses that the reference of a sentence is a proposition in primitive form and that computation is unfolding the definitions of objects to their primitive forms. In this talk, we will raise the following three objections to Martin-Löf's semantic distinction:

- We argue that his theory of sameness of sense as synonymy contradicts the view of senses as programs inspired by Dummett. This is because Martin-Löf identifies two expressions when they have the same value even when they are evaluated in a different way. For example, 10^{10} and 10000000000 are identical as senses for Martin-Löf but they seem to be two programs that compute differently.
- Martin-Löf [3] claims that functional expressions do not have references unless they are supplied with arguments. However, we maintain that functional expressions can have lazy references at least according to Martin-Löf's view of computation as the unfolding of definitions. Some functional expressions are defined in terms of more primitive ones. For example, "$\neg X$" as "$X \to \bot$". This means the senses of expressions of this kind can be computed and we can have their lazy references.
- Martin-Löf [3] borrows the scholastic notion of supposition as what an expression stands for on a particular occasion of its use. He distinguishes between meaning and referential supposition. He holds that in the judgment $a : A$, we have meaning supposition on the left side of the colon and referential supposition on the right side. For him, this referential supposition has to do with the fact that when $a : A$ and $A = B : type$ we can conclude that $a : B$. We object to his views by finding a similar rule in type theory that is inconsistent with this claim.

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[1] M. Dummett, *Frege's distinction between sense and reference*, ***Truth and Other Enigmas***, Harvard University Press, Cambridge, 1978, pp. 116–144.

[2] M. Dummett, *Sense and reference from a constructivist standpoint*, ***Bulletin of Symbolic Logic***, vol. 27 (2021), no. 4, pp. 485–500.

[3] P. Martin-Löf *The sense/reference distinction in constructive semantics*, ***Bulletin of Symbolic Logic***, vol. 27 (2021), no. 4, pp. 501–513.

► DAISUKE IKEGAMI AND NAM TRANG, *Preservation of* AD *via forcings.*
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The research in this talk was motivated by the following question:

Could there be an elementary embedding $j : V \to V[G]$ such that G is set-generic over V, $(V[G], \in, j)$ is a model of ZF, V is a model of AD, and the critical point of j is ω_1^V?

The positive answer to the above question would give us a poset which preserves AD while adding a new real. However, we still do not know if there is such a poset. To see whether there could be such a poset, we have been working on the question what kind of posets preserve AD.

In this talk, we present several results on posets preserving AD. Among them are the following:

1. Assume $\mathsf{ZF} + \mathsf{AD}^+ +$ "$V = \mathrm{L}(\wp(\mathbb{R}))$". Suppose that a poset $\mathbb{P}$ increases Θ, i.e., $\Theta^V < \Theta^{V[G]}$ for any $\mathbb{P}$-generic filter G over V. Then the poset $\mathbb{P}$ does not preserve AD.
2. Assume $\mathsf{ZF} + \mathsf{AD}$. Then any non-trivial poset which is a surjective image of $\mathbb{R}$ does not preserve AD.
3. Assume $\mathsf{ZF} + \mathsf{AD}^+ +$ "$V = \mathrm{L}(\wp(\mathbb{R}))$". Suppose that Θ is regular. Then there is a poset $\mathbb{P}$ on Θ which preserves AD and adds a new subset of Θ.

The item 2 above answers the question of Chan and Jackson [1]. The item 3 in case of $V = \mathrm{L}(\mathbb{R})$ answers the question of Cunningham [2].

A preprint on this work is available: https://arxiv.org/abs/2304.00449.

[1] William Chan and Steve Jackson, *The destruction of the axiom of determinacy by forcings on* $\mathbb{R}$ *when* Θ *is regular*, ***Israel Journal of Mathematics***, vol. 241 (2021), no. 1, pp. 119–138.

[2] Daniel W. Cunningham, *On forcing over* $\mathrm{L}(\mathbb{R})$, ***Archive for Mathematical Logic***, vol. 62 (2023), no. 3-4, pp. 359–367.

► RYO KASHIMA, TAISHI KURAHASHI AND SOHEI IWATA, *Cut-free sequent calculi for the provability logic D.*
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We say that a Kripke model is a GL-model if the accessibility relation $\prec$ is transitive and converse well-founded. We say that a Kripke model is a D-model if it is obtained by attaching infinitely many worlds $t_1, t_2, \ldots$, and t_ω to a world t_0 of a GL-model so that

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$t_0 \succ t_1 \succ t_2 \succ \cdots \succ t_\omega$. A non-normal modal logic **D**, which was studied by Beklemishev [1], is characterized as follows. A formula φ is a theorem of **D** if and only if φ is true at t_ω in any D-model.

D is a provability logic as follows. A formula φ is a theorem of **D** if and only if any φ^* is true in the standard model of arithmetic, where φ^* is obtained from φ by interpreting the modal operator $\Box$ as the provability predicate of arithmetic that is Σ_1-sound but not sound. **D** is an intermediate logic between the provability logics **GL** and **S**.

A Hilbert-style proof system for **D** is known, but there has been no sequent calculus. We establish two sequent calculi for **D**, and show cut-elimination theorems syntactically (for one calculus) and semantically (for both calculi). The syntactic proof is reduced to the cut-elimination for **S** by Kushida [2]. The semantical proofs are obtained by showing the completeness of cut-free sequent calculi.

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► ZIHUI LIANG, *Network control games played on graphs.*
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We investigate network-control games played on graphs. These games belong to the class of scoring games in combinatorial game theory. In a network-control game, two players move alternatively on a given graph. At each turn, a player selects an unclaimed vertex and its unclaimed neighbours within distance t. The goal is to decide which player claims the majority of the vertices at the end of the play. We solve and investigate the complexity of the network-control games on various classes of graphs, such as paths, linear forests, and hub-and-spoke graphs. We also study greedy, symmetric and optimal strategies. In the context of scoring games, most of the concepts and techniques developed in this paper are novel. They contribute to a further understanding of scoring games.

This is a joint work with Bakh Khoussainov and Mingyu Xiao.

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The theory of numbering holds a pivotal significance in the realms of computability theory and mathematical logic. Numberings serve as a powerful tool for investigating constructive objects by utilizing a set of natural numbers. However, they are also intriguing subjects of study in their own right. A significant concept in this context is the idea of reducibility between numberings. If one numbering can be effectively transformed into another, we say it is reducible to the second numbering. This notion of reducibility allows us to measure the relative complexity of numberings for objects within the same family.

Consequently, we encounter the Rogers upper semilattice of the family, where the elements are the degrees of numberings. The Rogers semilattice enables us to assess the various computations within a given family and serves as a tool for classifying properties of computable numberings for different families. In this presentation, we will explore the structural properties of the Rogers semilattice concerning various reducibility relations and different families of sets, especially within the framework of punctual computability,

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which is focused on eliminating unbounded search from constructions in algebra and infinite combinatorics. We show that any infinite, uniformly primitive recursive family induces an infinite Rogers pr-semilattice. We prove that the semilattice does not have minimal elements, and every nontrivial interval inside the semilattice contains an infinite antichain. In addition, every non-greatest element from the semilattice is part of an infinite antichain. We show that the Σ_1-fragment of the theory is decidable.

This presentation base on join work with N. Bazhenov and S. Ospichev.

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