

2023 NORTH AMERICAN ANNUAL MEETING
OF THE ASSOCIATION FOR SYMBOLIC LOGIC

University of California Irvine
Irvine, CA, USA
March 25–29, 2023

Please note: This program is a draft for the upcoming ASL North American meeting.

Program Committee: Matt Foreman, Marjin Heule, Teresa Kouri Kissel, Tim McNicholl and Rahim Moosa (chair).

Local Organizing Committee: Matt Foreman, Isaac Goldbring (chair), Toby Meadows, Kai F. Wehmeier and Martin Zeman.

Coffee and registration will take place in the Interdisciplinary Science and Engineering Building (ISEB). The plenary and tutorial talks will be held in the ISEB Auditorium. The special session and contributed talks will be held in rooms 2020, 4020 and 5020 of ISEB as well as the ISEB Colloquium Room and the ISEB Auditorium. The welcoming reception will be held at 7:00pm on Saturday March 25.

SATURDAY, March 25

Morning

- 8:30 – 9:30 Registration and coffee.
9:30 – 10:30 Invited Lecture: **Jakob Nordström** (University of Copenhagen),
TBA.
10:30 – 11:00 Coffee and registration.
11:00 – 12:00 Tutorial Lecture 1: **Natasha Dobrinen** (University of Notre Dame),
Ramsey theory on infinite structures, part 1.

Afternoon

- 2:00 – 4:00 Special Session B1, C1, D1 and E1. See pages 2–5.
4:00 – 4:30 Coffee and registration.
4:30 – 5:30 Gödel Lecture: **Carl G. Jockusch, Jr.** (University of Illinois at Urbana-Champaign), *From algorithms which succeed on a large set of inputs to the Turing degrees as a metric space*.
7:00 – 9:00 Welcoming Reception.

SUNDAY, March 26

Morning

- 9:00 – 9:30 Registration and coffee
9:30 – 10:30 Invited Lecture: **Maureen Eckert** (University of Massachusetts Dartmouth), *Suddenly, feminist logic?*
10:30 – 11:00 Registration and coffee.
11:00 – 12:00 Tutorial Lecture 2: **Natasha Dobrinen** (University of Notre Dame),
Ramsey theory on infinite structures, part 2.

Afternoon

- 2:00 – 3:00 Special Session A1, C2, D2, E2 and F1. See pages 2–5.

- 3:00 – 4:00 Special Session A2, B2, C3, D3 and F2. See pages 2–5.
 4:00 – 4:30 Coffee.
 4:30 – 5:30 Invited Lecture: **Nick Ramsey** (University of Notre Dame),
Model-theoretic tree properties: developments and prospects.

MONDAY, March 27

Morning

- 8:30 – 9:00 Coffee.
 9:00 – 10:00 Tutorial Lecture 1: **Marcin Sabok** (McGill University), *Complete orbit equivalence relations, part 1.*
 10:00 – 10:30 Coffee.
 10:30 – 11:30 Special Session A3, C4, E3 and F3. See pages 2–5.
 11:30 – 12:30 Special Session A4, B3, C5 and F4. See pages 2–5.

TUESDAY, March 28

Morning

- 9:00 – 9:30 Coffee.
 9:30 – 10:30 Invited Lecture: **Dino Rosseger** (University of California Berkeley),
Pairs of structures: variations and applications.
 10:30 – 11:00 Coffee.
 11:00 – 12:00 Tutorial Lecture 2: **Marcin Sabok** (McGill University), *Complete orbit equivalence relations, part 2.*

Afternoon

- 2:00 – 3:00 Invited Lecture: **Jindrich Zapletal** (University of Florida), *Algebra and axiom of choice.*
 3:00 – 4:00 Special Session A5, B4, E4 and F5. See pages 2–5.
 4:00 – 4:30 Coffee.
 4:30 – 6:05 Contributed Talks. See pages 6–6.

WEDNESDAY, March 29

Morning

- 8:30 – 9:00 Coffee.
 9:00 – 10:00 Invited Lecture: **Tomás Ibarlucía** (Université Paris Cité, CNRS),
Extremal models in affine logic.
 10:00 – 10:30 Coffee.
 10:30 – 11:30 Special Session B5, E5 and F6. See pages 2–5.
 11:30 – 12:30 Invited Lecture: **Ralf Schindler** (Universität Münster), *Martin's Maximum, Woodin's (*), and beyond.*

SPECIAL SESSIONS

A. Computability Theory

(Organized by Johanna Franklin and Matthew Harrison-Trainor)

Session A1: Sunday, March 26 in ISEB 2020

- 2:00 – 2:25 **Karen Lange** (Wellesley College), *Determining lengths of well-ordered subsets of ordered abelian groups.*

2:30 – 2:55 **Joseph S. Miller** (University of Wisconsin–Madison), *The Hausdorff dimension of continuous images.*

Session A2: Sunday, March 26 in ISEB 2020

3:00 – 3:25 **Elvira Mayordomo** (Universidad de Zaragoza), *Extensions of the point to set principle.*

3:30 – 3:55 **Rachael Alvir** (University of Waterloo), *Scott complexity and groups.*

Session A3: Monday, March 27 in ISEB 2020

10:00 – 10:25 **Liling Ko** (Ohio State University), *A computably small set that is not intrinsically small.*

10:30 – 10:55 **Alexander Melnikov** (Victoria University, Wellington), *Computable duality in effective topology.*

Session A4: Monday, March 27 in ISEB 2020

11:30 – 11:55 **Francesca Zaffora Blando** (Carnegie Mellon University), *TBA.*

12:00 – 12:25 **Oscar Levin** (University of Northern Colorado), *Asymptotic density and the computability of graphs.*

Session A5: Tuesday, March 28 in ISEB 2020

3:00 – 3:25 **Reed Solomon** (University of Connecticut), *Vertex pursuit games and well ordering graphs.*

3:30 – 3:55 **Patrick Lutz** (University of California Los Angeles), *Encoding information into all infinite subsets of a dense set.*

B. Descriptive Dynamics

(Organized by Su Gao and Steve Jackson)

Session B1: Saturday, March 25 in ISEB 4020

2:00 – 2:50 **Jenna Zomback** (Williams College), *Weak mixing for semigroup actions and applications to pointwise ergodic theorems.*

3:00 – 3:50 **Filippo Calderoni** (Rutgers University), *A descriptive view of the space of left-orderings.*

Session B2: Sunday, March 26 in ISEB Auditorium

3:00 – 3:25 **Zoltán Vidnyánszky** (California Institute of Technology), *Homomorphism problems in the infinite context.*

3:30 – 3:55 **Assaf Shani** (Harvard University), *Actions of Polish wreath product groups.*

Session B3: Monday, March 27 in ISEB Auditorium

11:30 – 12:20 **Shaun Allison** (University of Toronto), *Polish groups which don't involve S_∞ .*

Session B4: Tuesday, March 28 in ISEB 4020

3:00 – 3:50 **Dominik Kwietniak** (Jagiellonian University), *Borel complexity of generic points and related sets.*

Session B5: Wednesday, March 29 in ISEB 4020

10:30 – 10:55 **Clinton Conley** (Carnegie Mellon University), *TBA.*

11:00 – 11:25 **Aristotelis Panagiotopoulos** (Carnegie Mellon University), *General relativity does not admit enough observables.*

C. Model Theory

(Organized by Özlem Beyarslan and Artem Chernikov)

Session C1: Saturday, March 25 in ISEB Colloquium Room

2:00 – 2:50 **Mariana Vicaria** (University of California Los Angeles), *Towards an imaginary Ax-Kochen/Ershov principle.*

3:00 – 3:50 **Nigel Pynn-Coates** (Ohio State University), *Monotone T-convex T-differential fields.*

Session C2: Sunday, March 26 in ISEB Colloquium Room

2:00 – 2:50 **Kyle Gannon** (University of California Los Angeles), *Some results concerning measures on ultraproducts.*

Session C3: Sunday, March 26 in ISEB Colloquium Room

3:00 – 3:50 **James Hanson** (University of Maryland), *Bounded ultraimaginary independence.*

Session C4: Monday, March 27 in ISEB Colloquium Room

10:30 – 11:20 **Alexi Block Gorman** (McMaster University), *Expansions by k -regular sets of reals: toward a characterization of V_k definability.*

Session C5: Monday, March 27 in ISEB Colloquium Room

11:30 – 12:20 **Alexis Chevalier** (Institute for Advanced Study), *An algebraic hypergraph regularity lemma.*

D. Proof Complexity Beyond Propositional Logic

(Organized by Olaf Beyersdorff and Susanna de Rezende)

Session D1: Saturday, March 25 in ISEB 5020

2:00 – 2:50 **Noah Fleming** (Memorial University), *The proof complexity of integer programming.*

3:00 – 3:50 **Meena Mahajan** (Institute of Mathematical Sciences, Chennai), *Quantified Boolean formulas: solving and proof complexity.*

Session D2: Sunday, March 26 in ISEB 5020

2:00 – 2:50 **Pavel Pudlák** (Czech Academy of Sciences), *Propositional proof complexity and first order theories.*

Session D3: Sunday, March 26 in ISEB 5020

3:00 – 3:50 **Robert Robere** (McGill University), *On propositional proofs and total search problems.*

E. Set Theory

(Organized by Gabe Goldberg and Martin Zeman)

Session E1: Saturday, March 25 in ISEB Auditorium

2:00 – 2:25 **Dominik T. Adolf** (University of North Texas), *Rudin-Keisler capturing and mutual stationarity at successors of singular cardinals.*

2:30 – 2:55 **Thomas Gilton** (University of Pittsburgh), *PCF theory and the Tukey spectrum.*

- 3:00 – 3:25 **Assaf Shani** (Harvard University), *Models of ZF set theory with deep failure of choice.*
- 3:30 – 3:55 **Benjamin Siskind** (Carnegie Mellon University), *Connections between measures in $L(\mathbb{R})$ and Martin's Conjecture.*

Session E2: Sunday, March 26 in ISEB Auditorium

- 2:00 – 2:50 **Nam Trang** (University of North Texas), *Forcing over models of determinacy.*

Session E3: Monday, March 27 in ISEB Auditorium

- 10:30 – 10:55 **Elliot Glazer** (Harvard University), *Projective paradoxes of (*).*
- 11:00 – 11:25 **Kaethe Minden** (Bard College at Simon's Rock), *Split principles.*

Session E4: Tuesday, March 28 in ISEB Auditorium

- 3:00 – 3:50 **Dima Sinapova** (Rutgers University), *Mutual stationarity and the failure of SCH.*

Session E5: Wednesday, March 29 in ISEB Auditorium

- 10:30 – 10:55 **Garrett Ervin** (California Institute of Technology), *Infinitary submodular functions and maximum flows.*
- 11:00 – 11:25 **William Chan** (University of North Texas), *A survey of combinatorics and size of sets under determinacy.*

F. Women in the History of Logic

(Organized by Sophia Connell and Frederique Janssen-Lauret)

Session F1: Sunday, March 26 in ISEB 4020

- 2:00 – 2:50 **Frederique Janssen-Lauret** (University of Manchester), *Ruth Barcan Marcus' contributions to modal logic.*

Session F2: Sunday, March 26 in ISEB 4020

- 3:00 – 3:50 **Teresa Kouri Kissel** (Old Dominion University), *Susan Stebbing and the commonsense nature of modus ponens.*

Session F3: Monday, March 27 in ISEB 4020

- 10:30 – 11:20 **Andrea Reichenberger** (University of Siegen), *From symbolic logic to computer science: Rózsa Péter's work on recursive functions and computability.*

Session F4: Monday, March 27 in ISEB 4020

- 11:30 – 12:20 **Gisele Dalva Secco** (Federal University of Santa Maria), *Loparić avec les lacaniens: notes on a translation.*

Session F5: Tuesday, March 28 in ISEB Colloquium Room

- 3:00 – 3:50 **Sara L. Uckelman** (Durham University), *What problem did Ladd-Franklin (think she) solve(d)?*

Session F6: Wednesday, March 29 in ISEB Colloquium Room

- 10:30 – 11:20 **Landon Elkind** (Western Kentucky University), *TBA.*

CONTRIBUTED TALKS

TUESDAY, March 28

Session A, 4:30-6:05, ISEB Room 2020.

- 4:30 – 4:50 **Samson Leung** (Carnegie Mellon University), *First stability cardinals of AECs.*
- 4:55 – 5:15 **Wentao Yang** (Carnegie Mellon University), *An NIP-like notion for abstract elementary classes.*
- 5:20 – 5:40 **David Gonzalez** (University of California, Berkeley), *The ω -Vaught's conjecture.*
- 5:45 – 6:05 **Henry Towsner** (University of Pennsylvania), *What is tame hypergraph regularity?*

Session B, 4:30-6:05, ISEB Room 4020.

- 4:30 – 4:50 **Russell Miller** (Queens College – CUNY), *Computability and the absolute Galois group of \mathbb{Q} .*
- 4:55 – 5:15 **Michał Tomasz Godziszewski** (University of Warsaw), *Tennenbaum's Theorem for quotient presentations of nonstandard models of arithmetic.*
- 5:20 – 5:40 **Owain Griffin** (Ohio State University), *Skepticism, Skolemism, and the standard model.*
- 5:45 – 6:05 **S. Kaan Tabakci** (University of California Davis), *Tonk in metainferences.*

Session C, 4:30-5:40, ISEB Room 5020.

- 4:30 – 4:50 **William Adkisson** (University of Illinois at Chicago), *The strong tree property and ITP.*
- 4:55 – 5:15 **Pedro E. Marun** (Carnegie Mellon University), *Subtrees with small branching number.*
- 5:20 – 5:40 **Kameryn Williams** (Sam Houston State University), *Non-tightness in class theory.*

Abstract of the invited 34th Annual Gödel Lecture

- **CARL G. JOCKUSCH, JR.**, *From algorithms which succeed on a large set of inputs to the Turing degrees as a metric space.*

Department of Mathematics, University of Illinois at Urbana-Champaign.

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This talk will be an incomplete survey of a large body of work in recent years on relations between computability and asymptotic density. The study of this area was suggested by the late Paul Schupp, who also played a key role in its development. Many other investigators made major contributions. Two natural notions of computability with algorithms which are correct on a set of density 1 (coarse and generic computability) will be defined and compared with each other, and their interactions with the Turing degrees will be described. Coarse computability will be generalized to consider algorithms which are total and are correct with lower density at least a prescribed real number $r \in [0, 1]$. This leads naturally to a function γ from sets of natural numbers to $[0, 1]$ such that $\gamma(A)$ is the supremum of all r such that A is coarsely computable at density r . The function Γ from the set of Turing degrees to $[0, 1]$ is defined by letting

$\Gamma(\mathbf{a})$ be the infimum of $\gamma(B)$ over all \mathbf{a} -computable sets B . B. Monin showed that if $\Gamma(\mathbf{a}) < 1/2$, then $\Gamma(\mathbf{a}) = 0$. It follows from this remarkable result and earlier work that the range of Γ is $\{0, 1/2, 1\}$. The value of $1 - \Gamma(\mathbf{a})$ can be thought of as the distance between the least Turing degree $\mathbf{0}$ and the degree \mathbf{a} . More generally, Hausdorff defined a natural distance between closed bounded sets in an arbitrary metric space, and in the context of Turing degrees, this distance, denoted $H(\mathbf{a}, \mathbf{b})$, can be calculated by relativizing Γ to the degrees \mathbf{a} and \mathbf{b} . The values of H are again 0, 1/2, and 1. The Turing degrees are studied as a metric space with the metric H , and in particular it is determined which distances occur most frequently in terms of Lebesgue measure and Baire category. Finally, a sufficient condition is given for a countable metric space with all distances equal to 0, 1/2, or 1 to be isometrically embeddable in the Turing degrees with the Hausdorff metric. It is left open whether all countable $\{0, 1/2, 1\}$ -valued metric spaces are isometrically embeddable in the Turing degrees.

Abstract of invited tutorials

- ▶ NATASHA DOBRINEN, *Ramsey theory on infinite structures*.

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Ramsey theory on infinite structures seeks to extend Ramsey's Theorem on colorings of m -sized subsets of the natural numbers to colorings of copies of a fixed substructure within an infinite structure. Having roots in Sierpiński's unavoidable two-coloring of pairs of rationals, this theory has grown over the decades, recently expanding in multiple directions. In this tutorial, we will lay out the fundamentals of big Ramsey degrees, discuss why they exist, present their characterizations, and map out the current state of the art, techniques, and open questions.

- ▶ MARCIN SABOK, *Complete orbit equivalence relations*.

Department of Mathematics and Statistics, McGill University, Montreal, Canada.

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The tutorial will cover the developments in the theory of orbit equivalence relations. We will start with an overview of the theory of Polish groups, discussing their structure and actions. We will then pass to the theory of Borel complexity and discuss the structure of orbit equivalence relations induced by Polish group actions, including the existence of complete orbit equivalence relations. Finally, we will discuss the complexity of affine homeomorphism of Choquet simplices and show its connections to several other classification problems, including those arising in topological dynamics and ergodic theory. The tutorial will end with a couple of open questions and directions for further research.

Abstracts of invited plenary lectures

- ▶ MAUREEN ECKERT, *Suddenly, feminist logic?*

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As new (and forthcoming) publications in feminist logic appear, it is reasonable to ask how we got here. Why feminist logic now? There is nothing new about feminism and feminist philosophy. The innovation is in its combination with logic, an area of formal inquiry frequently understood as unconcerned with content and contexts regarding *anything whatsoever*. Is this a symptom of "wokeness" arriving at its ultimate

destination, tearing down the castle gate of pure formality? Not so fast. The current interest in feminist logic is a *renewed* interest. Val Plumwood’s 1993 article, “The Politics of Reason: Towards a Feminist Logic,” *Australian Journal of Philosophy* 71 (4), pp. 436–462 failed to gain the dynamic traction it has currently, not merely because logicians ignored it. Feminist theorists also did so. At the same time, crucially, the field of logic in the 1990’s had yet to undergo a sea-change regarding non-classical logics. The battle around Quine’s principle of conservatism paved the way to feminist logic. Quinean conservatism shaped the evolution and acceptance of “progressive” research projects. While not an apparent political conservatism, the branding of some research topics as “radical” was an unfortunate consequence. The marginalization of approaches to non-classical logic took time to overcome, and this process changed the field in remarkable ways. Dogmatism masquerading as conservatism was effectively put on notice. Current neo-Quinean arguments for conservatism about logic can no longer have the same type of impact on the field. It is now an historical epicycle. Feminist logics and forthcoming innovations are in-house matters. They are not trendy responses to current political interests, but reflect deeper, longstanding battles about what limitations, if any, pertain to research in logic.

- ▶ TOMÁS IBARLUCÍA, *Extremal models in affine logic*.
 Institut de Mathématiques de Jussieu–Paris Rive Gauche, Université Paris Cité, CNRS, Campus Grands Moulins – bât. Sophie Germain – Case 7012, 75205 Paris CEDEX13, France.

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We call affine logic the fragment of continuous logic in which the connectives are limited to linear combinations and the constants (but quantification is allowed, in the usual continuous form). This fragment has been introduced and studied by S.M. Bagheri, the first to observe that this is the appropriate framework to consider convex combinations of metric structures and, more generally, ultrameans, i.e., ultraproducts in which the ultrafilter is replaced by a finitely additive probability measure. Bagheri has shown that many fundamental results of continuous logic hold in affine logic in an appropriate form, including Los’s theorem, the compactness theorem, and the Keisler–Shelah isomorphism theorem.

In affine logic, type spaces are compact convex sets. In a recent joint work with I. Ben Yaacov and T. Tsankov, we initiate the study of extremal models in affine logic, i.e., those that only realize extreme types.

In this talk I will review the basics of affine logic and extreme types, discuss the characterization of extremal models in some important examples, and present an extremal decomposition result for models of simplicial affine theories, which generalizes the ergodic decomposition theorem.

- ▶ JAKOB NORDSTRÖM, *Leveraging computational complexity theory for provably correct combinatorial optimization*.

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The last couple of decades has witnessed a revolution in combinatorial optimization, with modern algorithms being used routinely to solve large-scale real-world problems, but the scientific understanding how these so-called combinatorial solvers can perform so well is quite poor. More importantly, even mature commercial solvers are known to sometimes produce wrong results, which can be fatal for some types of applications.

We will discuss how computational complexity theory can be leveraged to develop proof logging for combinatorial solvers, meaning that the algorithms output not only a result but also a proof of correctness. In this way, state-of-the-art solvers can be enhanced to produce simple, machine-verifiable certificates that provide ironclad mathematical guarantees that their computations are accurate.

- ▶ NICHOLAS RAMSEY, *Model-theoretic tree properties: developments and prospects*.
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The first model-theoretic tree properties were introduced by Shelah as a by-product of his analysis of forking in stable theories. Since then, other tree properties have appeared and, together, these combinatorial dividing lines (TP, TP₁/SOP₂, TP₂, SOP₁,...) serve as the basis for a growing body of research in model theory. I'll motivate this line of work and survey recent developments in the area (and try to justify the idea that it can be understood as an area). The emphasis will be on explaining three of the core ingredients in the theory developed so far: generalized indiscernibles, dividing at a generic scale, and amalgamation.

- ▶ DINO ROSSEGGER, *Pairs of structures: variations and applications*.
Department of Mathematics, University of California, Berkeley and Institute of Discrete Mathematics and Geometry, Technische Universität Wien, Austria.
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The pairs of structure theorem, proved by Ash and Knight in 1990, is one of the most influential results in computable structure theory and at the heart of many major theorems in the area. In this talk we review several variations of this theorem and applications both in computable structure theory and beyond. We present two results using versions of the pairs of structure theorem in areas other than computability theory. The first is a theorem by the author on the completeness of the elementary bi-embeddability relation under Borel reducibility. The second is joint work with Fedor Pakhomov on uniform reflection principles: We give a new proof of Feferman's completeness theorem, providing exact bounds on the amount of reflection needed to prove true sentences of Peano arithmetic.

- ▶ RALF SCHINDLER, *Martin's Maximum, Woodin's (*), and beyond*.
Institut für mathematische Logik und Grundlagenforschung, Fachbereich Mathematik und Informatik, Universität Münster.
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In 2019, D. Asperó and I showed that Martin's Maximum implies Woodin's \mathbb{P}_{\max} axiom (*), thereby amalgamating two prominent maximality principles which has sometimes been considered as competitors. Since then, variants of the "(*)-forcing" have been studied and applied to other problems. For instance, my student A. Lietz obtained a forcing extension in which NS_{ω_1} is ω_1 -dense. Many interesting open questions remain.

- ▶ JINDRICH ZAPLETAL, *Algebra and axiom of choice*.
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Geometric set theory provides a methodology for a very fine stratification of Σ_1^2 sentences over the choiceless base theory ZF+DC (the Axiom of Dependent Choices). In this talk, I will show how various dimension distinctions in algebra translate into independence results in ZF+DC. As a motivating result, for a number $n \geq 1$ let G_n be the graph on \mathbb{R}^n connecting points of rational Euclidean distance. Komjáth proved

that the graphs G_n all have countable chromatic number in ZFC. On the other hand, I will show that for every number $n \geq 1$ it is consistent with ZF+DC that G_n has countable chromatic number while G_{n+1} does not.

[1] PAUL LARSON AND JINDRICH ZAPLETAL, *Geometric set theory*, Mathematical Surveys and Monographs, American Mathematical Society, 2020.

[2] JINDRICH ZAPLETAL, *Coloring the distance graphs*, *Journal of the European Mathematical Society*, accepted.

[3] PÉTER KOMJÁTH, *Decomposition theorem for \mathbb{R}^n* , *Proceedings of the American Mathematical Society*, vol. 120 (1994), pp. 921–927.

Abstracts of invited talks in the Special Session on Computability Theory

- ▶ RACHAEL ALVIR, *Scott complexity and groups*.

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Scott’s Isomorphism Theorem states that every countable structure can be described up to isomorphism (among countable structures) by a single sentence of $L_{\omega_1\omega}$ known as its Scott sentence. Here, $L_{\omega_1\omega}$ is the extension of finitary first-order logic obtained by allowing countably infinite conjunctions and disjunctions. Each structure has a least complexity Scott sentence in the hierarchy of Π_α , Σ_α , and d - Σ_α formulas known as its Scott complexity. In this talk, we compute the Scott complexity of several kinds of groups.

- ▶ LILING KO* AND JUSTIN MILLER, *A computably small set that is not intrinsically small*.

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We construct a set A that is computably small but not intrinsically small. To understand these terms, we liken A to a game show host playing against a class of computable contestants, analogous to an infinite variant of the Monty Hall problem. The host has infinitely many doors arranged in a line, and each door hides either a goat or a car. A contestant selects infinitely many doors to open, and wins if a non-zero density of the selected doors contain a car. Contestants that are disorderly can select doors out of order, opening door i after door $j > i$. Are disorderly contestants more difficult to beat than orderly ones? This is known to be true if contestants are allowed to be adaptive, where they may choose a different door depending on the outcomes of the previously opened ones [1] (via the theorem that MWC-stochasticity 0 does not imply Kolmogorov-Loveland-stochasticity 0). We give a constructive proof to show that the statement also holds in the non-adaptive setting.

[1] W. MERKLE, J.S. MILLER, A. NIES, ANDRÉ, J. REIMANN AND F. STEPHAN, *Kolmogorov–Loveland randomness and stochasticity*, *Annals of Pure and Applied Logic*, vol. 138 (2006), no. 1-3, pp. 183–210.

- ▶ KAREN LANGE, *Determining lengths of well-ordered subsets of ordered abelian groups*. Department of Mathematics, Wellesley College, 106 Central St., Wellesley MA 02481, USA.

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We study the complexity of determining whether a well-ordered subset of an ordered abelian group has order type at least α . We focus on well-ordered subsets of ordered groups that arise naturally from the group operation, specifically the set of sums $A+B$ of two well ordered subsets A and B of a group G and the set of finite sums $[C]$ of elements from a well-ordered subset C of $G^{\geq 0}$. This work is joint with Chris Hall and Julia Knight.

- ▶ OSCAR LEVIN, *Asymptotic density and the computability of graphs.*

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Starting 20 years ago (with [3]), computability theorists have used asymptotic density as a tool to investigate the phenomenon that often non-computability in a structure shows up only in “rare” special cases. This leads to the notion of *generically* and *coarsely* computable sets, functions, and structures; ones that are computable except for exceptions that occur with zero density. For example, see the survey [2] for *pure* computability theory work, and [1] for applications to equivalence and injection structures.

In this talk we will consider how these questions interact with computable graph theory in three directions. First, we look at which graphs are generically computable and then wonder about how this question could be made more interesting. Then, we restrict to computable graphs and ask whether it is easier to properly color the vertices if we can be wrong on a set of small density. Finally, we consider *equitable colorings* of graphs: those for which each color used is used an “equal” number of times.

[1] WESLEY CALVERT, DOUGLAS CENZER, AND VALENTINA HARIZANOV, *Densely computable structures*, *Journal of Logic and Computation*, vol. 32 (2022), no. 3, pp. 581–607.

[2] CARL JOCKUSCH AND PAUL SCHUPP, *Asymptotic density and the theory of computability: a partial survey*, *Computability and complexity*, Lecture Notes in Computer Science, vol. 10010 (2017), Springer, pp. 501-520.

[3] ILYA KAPOVICH, ALEXEI MYASNIKOV, PAUL SCHUPP, AND VLADIMIR SHPILRAIN, *Generic-case complexity, decision problems in group theory, and random walks*, *Journal of Algebra*, vol. 264 (2003), no. 2, pp. 665–694.

- ▶ PATRICK LUTZ, *Encoding information into all infinite subsets of a dense set.*

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Suppose you have a noncomputable set X and you want to find a set A , all of whose infinite subsets compute X . There are several ways to do this, but all of them seem to end up producing a set A which is fairly sparse. It turns out that this is necessary in the following technical sense: if X is noncomputable and A is a set of positive lower density then A has an infinite subset which does not compute X . I will explain the main ideas of the proof of this theorem and also discuss limitations on extending it and its connection to work on the reverse math of Ramsey’s theorem. This is joint work with Matthew Harrison-Trainer.

- ▶ ELVIRA MAYORDOMO, *Extensions of the point to set principle.*

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Effective and resource-bounded dimensions were defined by Lutz in [5] and [4] and have proven to be useful and meaningful for quantitative analysis in the contexts of algorithmic randomness, computational complexity and fractal geometry (see the surveys [1, 6, 2, 12] and all the references in them).

The point-to-set principle of J. Lutz and N. Lutz [8] fully characterizes Hausdorff and packing dimensions in terms of effective dimensions in the Euclidean space, enabling effective dimensions to be used to answer open questions about fractal geometry, with already an interesting list of geometric measure theory results (see [3, 11] and more recent results in [7, 14, 16, 15]).

In this talk I will review the point-to-set principles focusing on its recent extensions to separable spaces [9], to resource-bounded dimensions [10] and to Finite-State dimensions [13].

[1] R. G. DOWNEY AND D. R. HIRSCHFELDT, *Algorithmic randomness and complexity*, Springer-Verlag, 2010.

[2] J. M. HITCHCOCK, J. H. LUTZ, AND E. MAYORDOMO, *The fractal geometry of complexity classes*, *SIGACT News Complexity Theory Column*, vol. 36 (2005), pp. 24–38.

[3] J. LUTZ AND N. LUTZ, *Who asked us? How the theory of computing answers questions about analysis*, *Complexity and Approximation: In Memory of Ker-I Ko* (Ding-Zhu Du and Jie Wang, editors), Springer, 2020, pp.48–56.

[4] J. H. LUTZ, *Dimension in complexity classes*, *SIAM Journal on Computing*, vol. 32 (2003), no. 5, pp.1236–1259.

[5] J. H. LUTZ, *The dimensions of individual strings and sequences*, *Information and Computation*, vol. 187 (2003), no. 1, pp. 49–79.

[6] J. H. LUTZ, *Effective fractal dimensions*, *Mathematical Logic Quarterly*, vol. 51 (2005), no. 1, pp. 62–72.

[7] J. H. LUTZ, *The point-to-set principle, the continuum hypothesis, and the dimensions of hamel bases*, *Computability*, to appear.

[8] J. H. LUTZ AND N. LUTZ, *Algorithmic information, plane Kakeya sets, and conditional dimension*, *ACM Transactions on Computation Theory*, vol. 10 (2018), article 7.

[9] J. H. LUTZ, N. LUTZ, AND E. MAYORDOMO, *Dimension and the structure of complexity classes*, *Theory of Computing Systems*, to appear.

[10] J. H. LUTZ, N. LUTZ, AND E. MAYORDOMO, *Dimension and the structure of complexity classes*, arXiv:2109.05956.

[11] J. H. LUTZ AND E. MAYORDOMO, *Algorithmic fractal dimensions in geometric measure theory*, *Handbook of Computability and Complexity in Analysis* (V. Brattka and P. Hertling, editors), Springer-Verlag, 2021, 271–302.

[12] E. MAYORDOMO, *Effective fractal dimension in algorithmic information theory*, *New Computational Paradigms: Changing Conceptions of What is Computable*, Springer-Verlag, 2008, pp. 259–285.

[13] E. MAYORDOMO, *A point to set principle for finite-state dimension*, arXiv:2208.00157.

[14] T. SLAMAN, *On capacitability for co-analytic sets*, *New Zealand Journal of Mathematics*, vol. 52 (2022), pp. 865–869.

[15] D. STULL, *Optimal oracles for point-to-set principles*, *39th International Symposium on Theoretical Aspects of Computer Science (STACS 2022)* (P. Berenbrink and B. Monmege, editors), Leibniz International Proceedings in Informatics, vol. 219, 2022, pp. 57:1–57:17.

[16] D. M. STULL, *The dimension spectrum conjecture for planar lines*, *49th*

International Colloquium on Automata, Languages, and Programming (ICALP2022) (M. Bojańczyk, E. Merelli, and D. P. Woodruff, editors), Leibniz International Proceedings in Informatics, vol. 229, 2022, pp. 133:1–133:20.

- ▶ ALEXANDER MELNIKOV, *Computable duality in effective topology*.
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The title of the talk is self-explanatory. I will talk about my recent work in computable topology and computable topological groups. Some of these results, especially those that are related to classification problems and duality theory, provide us with direct links between computable structure theory, effective topology, and computable Banach space theory. This talk will be based on several papers written jointly with Ng, Downey, Nies, Lupini, Turetsky, Franklin, Harrison-Trainor, and Bazhenov.

- ▶ JOSEPH S. MILLER, *The Hausdorff dimension of continuous images*.
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What effect do continuous functions have on Hausdorff dimension? An uncountable analytic set $E \subseteq \mathbb{R}^2$ must have a perfect subset, so it can be mapped continuously onto $[0, 1]^2$ —a set of dimension 2—regardless of the Hausdorff dimension of E . On the other hand, assuming CH, Patrick Lutz and I constructed a set $E \subseteq \mathbb{R}^2$ of Hausdorff dimension 1 such that any continuous image of E in \mathbb{R}^2 has dimension at most 1. Moreover, we can ensure that if $f: \mathbb{R}^2 \rightarrow \mathbb{R}$ is continuous, then $f[E]$ has Hausdorff dimension 0. The first fact generalizes to any Hausdorff dimension $s \in [0, 2]$, but the second does not. Don Stull and I constructed a continuous function $j: \mathbb{R}^2 \rightarrow \mathbb{R}$ such that if $E \subseteq \mathbb{R}^2$ has Hausdorff dimension $s > 1$, then $j[E]$ has dimension at least $s/2$. In other words, j (at worst) preserves the relative dimension of sets of Hausdorff dimension greater than 1. The work with Patrick Lutz implies that, in general, this is best possible.

These results are proved in the effective setting and then “classicalized” using the point-to-set principle of Jack Lutz and Niel Lutz.

- ▶ REED SOLOMON, *Vertex pursuit games and well ordering graphs*.
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There are two commonly used types of well orderings of countable graphs. A *constructible* (or *dominating*) *order* describes how a graph can be built in an ordinal number of stages so that each node is dominated when it enters the graph. A *dismantling order* describes how a graph can be taken apart in an ordinal number of stages so that each node is dominated when it is removed. These orders are closely connected to the existence of winning strategies in various vertex pursuit games. This talk will survey recent results on the complexity of these orders on computable graph and will give connections to games on graphs. The results are joint work with Leigh Evron, Tyler Markkanen and Shelley Stahl.

- ▶ FRANCESCA ZAFFORA BLANDO, *Randomness and invariance*.
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The first (semi-)formal definition of randomness for infinite binary sequences dates

back to von Mises' work in the foundations of probability and statistics. According to von Mises, a sequence is random if, within it, the relative frequencies of 0 and 1 converge to a limit and these limiting relative frequencies are invariant under a class of transformations called selection rules. The randomness notion introduced by von Mises is nowadays widely regarded as being too weak and his account has been supplanted by the theory of algorithmic randomness, which characterizes randomness using the tools of computability theory and measure theory. The goal of this talk is two-fold. First, I will discuss a lesser-known characterization of Schnorr randomness due to Schnorr, which demonstrates that it is possible to obtain a satisfactory randomness notion by defining randomness, analogously to how von Mises did it, in terms of the invariance of limiting relative frequencies. Then, I will discuss how other canonical algorithmic randomness notions are similarly characterizable in terms of invariance: that is, in terms of the preservation of natural properties under various classes of transformations. This talk is based on joint work with Floris Persiau.

**Abstracts of invited talks in the Special Session on
Descriptive Dynamics**

- ▶ SHAUN ALLISON, *Polish groups which don't involve S_∞* .
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Say that a Polish group G involves a Polish group H iff there is a closed subgroup G_0 of G and a closed normal subgroup N of G_0 such that $G_0/N \cong H$. The group S_∞ is the Polish group of (full-support) permutations of \mathbb{N} , and the non-Archimedean Polish groups are exactly the closed subgroups of S_∞ , or equivalently, the Polish groups with a countable local basis of the identity of open subgroups.

We argue that the class of non-Archimedean Polish groups which don't involve S_∞ has a deep and interesting theory. We give several very different statements that are all equivalent to a Polish group not involving S_∞ , ranging from the failure of a weakening of disjoint amalgamation, to the existence of a certain kind of ordinal rank, to its actions having a certain kind of generic ergodicity. Time permitting, we will also discuss some metamathematical statements which are also equivalent to a Polish group not involving S_∞ .

- ▶ FILIPPO CALDERONI, *A descriptive view of the space of left-orderings*.
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In this talk we discuss how invariant descriptive set theory can be used to recover information about the space of left-orderings $\text{LO}(G)$ of a given countable group G . In particular, we will discuss some new techniques to prove that the conjugacy relation on $\text{LO}(G)$ is not smooth for a large class of simple groups and knot groups.

- ▶ DOMINIK KWIETNIAK, *Borel complexity of generic points and related sets*.
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We discuss the descriptive complexity of sets of points defined by placing restrictions on statistical behaviour of their orbits in dynamical systems on Polish spaces. A particular example is set of points generic for an invariant measure. We also consider much more general sets (for example, α -Birkhoff regular sets and the irregular set appearing in multifractal analysis of ergodic averages of a continuous real-valued function). We

show that all these sets are Borel when we assume that our space is compact. We provide examples showing that for non-compact spaces some of these sets are non-Borel, properly placed at the first level of the projective hierarchy (they are complete analytic or co-analytic). When these sets are Borel, we use the Borel hierarchy to measure their descriptive complexity. We show that the sets of interest are located at most at the third level of the hierarchy. We also use a modified version of the specification property to show that for many dynamical systems these sets are properly located at the third level of the hierarchy. These result allow us to determine the Borel complexity of sets of numbers defined by placing restrictions on statistical behaviour of digits of their expansion in a numeration system. In particular, normal numbers in several numeration systems. We offer a unified treatment for continued fraction expansions and base r expansions, and their various generalisations: generalised Lüroth series expansions and β -expansions. The talk is based on results obtained with Dylan Airey, Konrad Deka, Steve Jackson, and Bill Mance, see [1] and [2].

[1] DYLAN AIREY, STEVE JACKSON, DOMINIK KWIETNIAK AND BILL MANCE, *Borel complexity of sets of normal numbers via generic points in subshifts with specification*, *Transaction of the American Mathematical Society*, vol. 373 (2020), no. 7, pp. 4561–4584.

[2] KONRAD DEKA, STEVE JACKSON, DOMINIK KWIETNIAK AND BILL MANCE, *Borel complexity of sets of points with prescribed Birkhoff averages in Polish dynamical systems with a specification property*, arXiv:2210.08937.

- ▶ ARISTOTELIS PANAGIOTOPOULOS, *General relativity does not admit enough observables*.

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One of the biggest open problems in mathematical physics has been the problem of formulating a complete and consistent theory of quantum gravity. Some of the core technical and epistemological difficulties come from the fact that General Relativity (GR) is fundamentally a geometric theory and, as such, it oughts to be “generally covariant”, i.e., invariant under change of coordinates by any element of the diffeomorphism group $\text{Diff}(M)$ of the ambient manifold M . The Problem of Observables is a famous instance of the difficulties associated with general covariance, and one directly related to ineffectiveness of classical quantization recipes when it comes to GR. In a nutshell, the problem of observables asks whether GR admits a complete set of smooth observables. That is, whether the family of all diffeomorphism-invariant, real-valued, smooth maps on the space $\text{Ein}(M)$ of all Einstein metrics on M is rich enough to separate all physical spacetimes. So far the only smooth observables known (when $M = \mathbb{R}^4$) are the constant maps. In this talk, we will employ methods from descriptive set theory in order to answer the problem of observables in the negative.

These results are in joint work with Marios Christodoulou and George Sparling.

- ▶ ASSAF SHANI, *Actions of Polish wreath product groups*.

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Following Clemens and Coskey, we study actions of Polish groups of the form $\Lambda \wr \Gamma = \Gamma \rtimes \Lambda^\Gamma$, where Γ, Λ are countable groups. We show that for sufficiently different Γ_1, Γ_2 , there is an orbit equivalence relation induced by $\Gamma_1 \wr \Gamma_1$ which is generically ergodic with respect to *any* orbit equivalence relation induced by $\Gamma_2 \wr \Gamma_2$. For example, this is the case when there are no non-trivial group homomorphisms from Γ_1 to Γ_2 .

- ▶ ZOLTÁN VIDNYÁNSZKY, *Homomorphism problems in the infinite context*.

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The CSP dichotomy is a celebrated theorem of computer science: it states that given a finite structure H , deciding whether a structure G admits a homomorphism to G is either easy (in P) or hard (NP -complete).

Thornton initiated the study of the question analogous to the CSP dichotomy in the Borel context. In my talk, I will discuss some results which indicate that the separation between the hard and easy problems differs in the Borel context from the finite case.

- ▶ JENNA ZOMBACK, *Weak mixing for semigroup actions and applications to pointwise ergodic theorems.*

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We provide a sufficient condition for the natural boundary action of free semigroups to be weak mixing. This result yields new pointwise ergodic theorems for free semigroup actions, where the averages are taken along trees. This is joint work with Anush Tserunyan.

Abstracts of invited talks in the Special Session on Model Theory

- ▶ ALEXI BLOCK GORMAN, *Expansions by k -regular sets of reals: toward a characterization of V_k definability.*

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Büchi automata are the natural extension of finite automata to a model of computation that accepts infinite-length inputs. We say a subset X of the reals is k -regular if there is a Büchi automaton that accepts (one of) the base- k representations of every element of X , and rejects the base- k representations of each element in its complement. These sets often exhibit fractal-like behavior—e.g., the Cantor set is 3-regular. Let $V_k \subseteq \mathbb{R}^3$ be a ternary predicate such that $V_k(x, u, d)$ holds if and only if $u \in k^{\mathbb{Z}}$ and $d \in \{0, 1, \dots, k-1\}$ is the coefficient of the term u in some base- k expansion of x . For a fixed k and for each $n \in \mathbb{N}$, all of the k -regular subsets of \mathbb{R}^n are \emptyset -definable in the structure $(\mathbb{R}, <, +, V_k)$. In this talk, we will discuss the significance of the structure $(\mathbb{R}, <, +, V_k)$ and its reducts from the perspectives of tame geometry and neostability. We will also discuss current and ongoing progress toward a characterization of the reducts of $(\mathbb{R}, <, +, V_k)$ in terms of definability, neostability, and fractal dimensions.

- ▶ ALEXIS CHEVALIER, *An algebraic hypergraph regularity lemma.*

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In [4], Tao proves the algebraic regularity lemma. This is a strong form of the Szemerédi regularity lemma for definable graphs in the language of rings in finite fields. The algebraic regularity lemma improves the Szemerédi regularity lemma by providing definable regular partitions of definable bipartite graphs which have no irregular pairs and such that the error bounds on regularity vanish as the size of the finite field grows.

Tao asks in [4] if the algebraic regularity lemma can be extended to definable hypergraphs, to strengthen the combinatorial regularity lemmas of [3] or [2]. In [1], we answer this question positively by giving a new analysis of the algebraic regularity lemma. We use the model theory of pseudofinite fields to relate the combinatorial

notion of regularity (for graphs and for hypergraphs) to Galois-theoretic information associated to definable sets. With this new analysis in hand, the algebraic hypergraph regularity lemma follows by classical results of Gowers, albeit with some interesting technical details.

[1] ALEXIS CHEVALIER AND ELAD LEVI, *An algebraic hypergraph regularity lemma*, arXiv:2204.01158.

[2] WILLIAM TIMOTHY GOWERS *Quasirandomness, counting and regularity for 3-uniform hypergraphs* **Combinatorics, Probability and Computing**, vol. 15 (2006), no. 1–2, pp. 143–184.

[3] VOJTĚCH RÖDL AND JOZEF SKOKAN *Regularity lemma for k -uniform hypergraphs* **Random Structures & Algorithms**, vol. 25 (2004), no. 1, pp. 1–42.

[4] TERENCE TAO *Expanding polynomials over finite fields of large characteristic, and a regularity lemma for definable sets*. **Contributions to Discrete Mathematics**, vol. 10 (2012), no. 11, pp. 22–98.

- ▶ KYLE GANNON, *Some results concerning measures on ultraproducts*.

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As consequence of the VC theorem, any pseudofinite measure over an NIP ultraproduct is generically stable. We demonstrate a converse of this theorem and prove that finitely approximable measures over a pseudofinite structure are themselves pseudofinite (even without the NIP assumption). We then analyze the connection between the Morley product and the pseudofinite product. We show that if μ is definable and μ and ν are both pseudofinite, then the Morley product agrees with the pseudofinite product. Using this observation, we can construct generically stable idempotent measures on pseudofinite NIP groups. Our goal is to classify generically stable idempotents in this context.

- ▶ JAMES HANSON, *Bounded ultraimaginary independence*.

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In the context of model theory, ultraimaginaries are an immediate generalization of hyperimaginaries defined in terms of equivalence classes of arbitrary invariant equivalence relations rather than type-definable equivalence relations. There is a natural model-theoretic independence notion that arises from the consideration of ultraimaginaries (analogous to the notion of algebraic independence). We will describe some properties of this independence notion and its corresponding 'generic' sequences, which are shown to be equivalent to a class of sequences originally considered by Shelah. We will end with some preliminary applications to amalgamation.

- ▶ ELLIOT KAPLAN AND NIGEL PYNN-COATES*, *Monotone T -convex T -differential fields*.

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Let T be a complete, model complete, power bounded o-minimal theory extending the theory of real closed fields. A T -convex T -differential field is an expansion of a

model of T by a valuation and a derivation, each of which is compatible with the o -minimal structure, the former in the T -convex sense of van den Dries–Lewenberg [1] and the latter in the sense of Fornasiero–Kaplan [2]. When $T = T_{\text{an}}$, the theory of the real field with restricted analytic functions, we can expand an ordered differential Hahn field to a T_{an} -convex T_{an} -differential field, in which case the derivation is monotone, i.e., weakly contractive with respect to the valuation (monotone differential Hahn fields were studied earlier by Scanlon [4] and Hakobyan [3]). We show that any other monotone T_{an} -convex T_{an} -differential field is elementarily equivalent to such an ordered differential Hahn field, which follows from a more general Ax–Kochen/Ershov type theorem for monotone T -convex T -differential fields. A key step is isolating an appropriate analogue of henselianity in this setting.

[1] L. VAN DEN DRIES AND A. LEWENBERG, *T-convexity and tame extensions*, *Journal of Symbolic Logic*, vol. 60 (1995), no. 1, pp. 74–102.

[2] A. FORNASIERO AND E. KAPLAN, *Generic derivations on o -minimal structures*, *Journal of Mathematical Logic*, vol. 21 (2021), no. 2, paper no. 2150007, 45 pp.

[3] T. HAKOBYAN, *An Ax-Kochen-Ershov theorem for monotone differential-henselian fields*, *Journal of Symbolic Logic*, vol. 83 (2018), no. 2, pp. 804–816.

[4] T. SCANLON, *A model complete theory of valued D -fields*, *Journal of Symbolic Logic*, vol. 65 (2000), no. 4, pp. 1758–1784.

- MARIANA VICARIA, *Towards an imaginary Ax-Kochen/Ershov principle*.

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One of the most striking results in the model theory of henselian valued fields is the Ax-Kochen theorem, which roughly states that the first order theory of a finitely ramified henselian valued field is completely determined by the first order theory of the residue field and its value group.

A model theoretic principle follows from this theorem: any model theoretic question about the valued field can be reduced into a question to its residue field, its value groups and their interaction in the field.

Our leading question is: Can one obtain an Ax-Kochen style theorem to eliminate imaginaries in henselian valued fields?

We will present results answering this question for the equicharacteristic zero case. This is joint work with Rideau-Kikuchi.

Abstracts of invited talks in the Special Session on Proof Complexity Beyond Propositional Logic

- NOAH FLEMING, *The proof complexity of integer programming*.

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We discuss recent progress on understanding modern integer programming algorithms. Proof complexity provides an elegant approach for studying the complexity of algorithms for solving NP-hard problems. The sequence of operations which an algorithm performs on an input can be viewed as a proof that the algorithm computed correctly. These proofs belong to some proof system and thus lower bounds on the size of proofs in that system imply the intractability of that algorithm. We take this approach in order to analyze modern integer programming algorithms. We introduce the Stabbing Planes proof system, which tightly models modern integer programming algorithms. To obtain lower bounds on the complexity of Stabbing Planes proofs, we

establish a surprisingly close relationship with Cutting Planes.

- ▶ MEENA MAHAJAN, *Quantified Boolean formulas: solving and proof complexity*.
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QBF solving brings many new challenges and has thrown up many innovative approaches and heuristics. QBF proof complexity explores the theoretical underpinnings of these approaches rigorously, explains relative strengths of different approaches, exposes limitations, and suggests new approaches. This talk will survey some of the developments in the area.

- ▶ PAVEL PUDLÁK, *Propositional proof complexity and first order theories*.
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Cook and Reckhow defined a general concept of a propositional proof system. Essentially, it is a nondeterministic Turing machine that accepts the set of all tautologies. One can compare propositional proof systems using polynomial simulations, or by comparing the lengths of the shortest proofs. Most of research in proof complexity focuses on weak proof systems, whose strengths can be analyzed and which have potentially practical applications. In this talk I will deal with strong systems. In order to fully understand strong propositional proof systems, we have to use first order theories, which can be viewed as very strong propositional proof systems. Recently I started working on a project whose main aims are

1. to give a combinatorial characterization of proof systems constructed from first order theories, at least for the weakest theories such as Robinson's Q;
2. construct hierarchies of proof systems indexed by constructive ordinals.

I will present some preliminary results in this direction.

- ▶ ROBERT ROBERE, *On propositional proofs and total search problems*.
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Recent work has illustrated a deep relationship between the theories of *propositional proof systems* and *total NP search problems* (TFNP). The basic correspondence allows us to associate a total search problem S with each propositional proof system P such that the following holds: for every tautology T , T has a short proof in P if and only if proving T can be “efficiently reduced” to proving the totality of S . This allows us to define a theory of reducibility for proof systems that is analogous to classical reducibility in complexity theory, and it has led to the resolution of a number of open problems in both proof complexity and the theory of TFNP. In this talk we will introduce and survey this recent work.

Abstracts of invited talks in the Special Session on Set Theory

- ▶ DOMINIK T. ADOLF, *Rudin-Keisler capturing and mutual stationarity at successors of singular cardinals*.
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Mutual Stationarity, introduced by Foreman and Magidor in [1], bridges the gap between the classical notion of stationarity on some cardinal κ with the generalized

stationarity on the power set of some set X . In this talk we will introduce a new large cardinal notion called Rudin-Keisler capturing that will allow us to generically add a sequence to the universe with strong mutual stationarity properties. As an example, starting from a model with an $\omega+2$ -strong cardinal, we will construct a model in which every sequence $(S_n : n < \omega)$ of stationary sets $S_n \subset \aleph_{\omega \cdot (n+1)+1} \cap \text{cof}(\aleph_1)$ is mutually stationary. This is part of joint work with Omer Ben-Neria.

[1] MATTHEW FOREMAN AND MENACHEM MAGIDOR, *Mutually stationary sequences of sets and the non-saturation of the non-stationary ideal on $P_\kappa(\lambda)$* , *Acta Mathematica*, vol. 186 (2001), no. 2, pp. 271–300.

- ▶ WILLIAM CHAN, *A survey of combinatorics and size of sets under determinacy*. Department of Mathematics, University of North Texas, 1155 Union Circle #311430, Denton, TX 76203.

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In this talk, we will survey recent results concerning the structure of cardinalities of sets and the combinatorics of sets under the axiom of determinacy. The talk will focus on combinatorial problems surrounding partition properties and almost everywhere behaviors of functions on partition spaces. As time permits, we may discuss a question of Goldberg concerning whether the ultrapower of the first uncountable strong partition cardinal of determinacy, ω_1 , by the strong partition measure on ω_1 can exceed the second strong partition cardinal of determinacy, $\omega_{\omega+1}$. We may also discuss the structure of the cardinalities of collections of ω -sequences through certain ordinals under various determinacy assumptions. Some portions of this talk is joint work with Stephen Jackson and Nam Trang.

- ▶ GARRETT ERVIN, *Infinitary submodular functions and maximum flows*. Division of Physics, Mathematics and Astronomy, California Institute of Technology.

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The cut function f of a finite hypergraph G is the function that, given a set of vertices X from G , returns the number of edges $f(X)$ on the boundary of X . Cut functions are *submodular*, that is, they satisfy the inequality

$$f(X \cup Y) + f(X \cap Y) \leq f(X) + f(Y)$$

for all $X, Y \subseteq V(G)$. The submodularity of cut functions is an important ingredient in the proof of the hypergraph max-flow min-cut theorem. In this talk we consider infinitary generalizations of hypergraphs in which hyperedges are replaced by filters on an underlying infinite vertex set. It turns out that the cut functions of these “filter graphs” are also submodular, and that in these graphs a natural generalization of the max-flow min-cut theorem holds.

- ▶ THOMAS GILTON, *PCF theory and the Tukey spectrum*. Department of Mathematics, The Dietrich School of Arts and Sciences, 301 Thackeray Hall, Pittsburgh, PA 15260.

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In this talk, we investigate the relationship between PCF and Tukey theories. The former, invented by Shelah, focuses on cofinal structure arising from products of sets of regular cardinals, modulo an ideal. The latter, which arose in the study of generalized notions of convergence in topology, compares directed posets in terms of their cofinal structure. Given a set A of regular cardinals, we can associate to it two other sets of regular cardinals, namely $\text{pcf}(A)$ (the set of possible cofinalities of A) and $\text{spec}(A)$ (the Tukey spectrum of A). The latter consists of all regular cardinals which are below $(\prod A, <)$ in the Tukey order.

It is immediate from the definitions that $\text{pcf}(A) \subseteq \text{spec}(A)$. However, it is a more subtle and interesting question when the two are equal (or when they are “close”). Gartside and Mamatelashvili ([1]) have recently shown that if A is a *progressive* set of regular cardinals, then $\text{spec}(A) \subseteq \text{pcf}(A) \cup \lim(\text{pcf}(A))$.

In this talk, we will discuss results of the speaker ([2]) giving a more detailed analysis of the relationship between these two sets of regular cardinals. We provide other conditions under which $\text{spec}(A) \subseteq \text{pcf}(A) \cup \lim(\text{pcf}(A))$, and we also provide a model in which for all sets A of regular cardinals, $\text{spec}(A) = \text{pcf}(A)$. Furthermore, we discuss the influence of “small” large cardinals on the structure of $\text{spec}(A)$, and we use this to discuss limitations to forcing constructions that might separate $\text{spec}(A)$ and $\text{pcf}(A)$. If time permits, we show that the Tukey spectrum can play a traditional PCF-theoretic role and lift the existence of Jónsson algebras from below a singular to hold at its successor.

[1] PAUL GARTSIDE AND ANNA MAMATELASHVILI, *Tukey Order, Calibres and the Rationals*, *Annals of Pure and Applied Logic*, vol. 172 (2016), no. 1, paper 102873, 18 pp.

[2] THOMAS GILTON, *PCF Theory and the Tukey Spectrum*, submitted.

- ▶ ELLIOT GLAZER, *Projective paradoxes of (*)*.

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We will discuss some consequences of $(*)$ concerning models of the form $(H(\omega_1), F)$ for $F \in \mathbb{R}^{\omega_1}$. We’ll use a prediction game to show there is $\alpha < \omega_1$ such that $F(\alpha)$ is definable over $(H(\omega_1), F \upharpoonright_{\omega_1 \setminus \{\alpha\}})$, a property which naively shouldn’t hold for a “randomly chosen” ω_1 -sequence of reals. Formalizing this intuition will provide us a robust characterization of CH over large cardinals in terms of the existence of two ω_1 -sequences of reals, one “structured” and the other “random.”

- ▶ KAETHE MINDEN, *Split principles*.

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The original split principle is an equivalent formulation of a cardinal failing to be weakly compact. Gunter Fuchs and I expanded the notion in order to characterize the negation of inaccessibility and other large cardinal properties. Some of these split principles give rise to seemingly new large cardinals. In this talk I plan to introduce split principles and compare them to splitting numbers and flipping properties.

- ▶ ASSAF SHANI, *Models of ZF set theory with deep failure of choice*.

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Let $V[G]$ be a set-generic extension of V , and $V \subset N \subset V[G]$ an intermediate model of ZF. If N satisfies the axiom of choice, then N is itself a set-generic extension of V . Intermediate models of ZF in which the axiom of choice fails are usually of the form $V(A)$: the minimal ZF extension of V containing A , for some set $A \in V[G]$.

The first intermediate model which is *not* of this form is the so called *Bristol model*. This is an intermediate model between L and an extension of L by a single Cohen real.

The existence of such a model answered a question of Grigorieff from 1975. The renewed interest in the question comes from more recent work of Woodin on the HOD conjecture and the AC conjecture. In this case the problem is of particular interest when large cardinals are involved. However, the Bristol model construction requires L -like assumptions on the ground model, prohibiting the existence of large cardinals to begin with.

We give a different construction of such “exotic inner model”, not requiring any assumption on the ground model. Specifically: for *any* ground model V there is an intermediate extension $V \subset N \subset V[c]$, where c is a single Cohen-generic real, so that N is not of the form $V(A)$ for any set A .

This result provides a complete solution to Grigorieff’s question. Furthermore, it opens the way to investigating the following question, related to Woodin’s AC conjecture: which large cardinals can exist in such a model N ?

This is joint work with Yair Hayut.

- ▶ DIMA SINAPOVA, *Mutual stationarity and the failure of SCH*.

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Mutual stationarity is a compactness type property for singular cardinals. Roughly, it asserts that given a singular cardinal κ , stationary subsets of regular cardinals with limit κ have a “simultaneous witness” for their stationarity. This principle was first defined by Foreman and Magidor in 2001, who showed that it holds for every sequence of stationary sets of cofinality ω . They also showed that their ZFC result does not generalize to higher cofinality. Whether the principle can consistently hold for higher cofinalities remained open, until a few years ago Ben Neria showed that from large cardinals mutual stationarity at $\langle \aleph_n \mid n < \omega \rangle$ can be forced for any fixed cofinality.

We show that we can obtain mutual stationarity at $\langle \aleph_n \mid n < \omega \rangle$ for any fixed cofinality together with the failure of SCH at \aleph_ω . This is joint work with Will Adkisson.

- ▶ BENJAMIN SISKIND, *Connections between measures in $L(\mathbb{R})$ and Martin’s Conjecture*.

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Martin’s Conjecture asserts that, under the Axiom of Determinacy, the only Turing-invariant functions are the natural ones: the constant functions, the identity, and iterates of the Turing jump. We’ll discuss some connections between this conjecture and some questions and results about ultrafilters in the determinacy context. In particular, we’ll discuss recent work which uses the analysis of the short generators of the Martin measure to make some progress on what remains of the order-preserving case of Martin’s Conjecture. This is joint work with Patrick Lutz.

- ▶ NAM TRANG, *Forcing over models of determinacy*.

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Forcing and elementary embeddings are central topics in set theory. Most of what set theorists have focused on are the study of forcing and elementary embeddings over models of ZFC.

In this talk, we focus on forcing and elementary embeddings over models of the Axiom of Determinacy (AD). In particular, we focus on answering the following questions. Let \mathbb{P} be a set forcing and $g \subset \mathbb{P}$ be V -generic.

1. Must $V[g] \models \neg\text{AD}$?
2. Is there an elementary embedding from V to $V[g]$?

We present some results that partially answer the questions above. Built on earlier work of Chan and Jackson, we have completed the proof of the following theorem.

THEOREM 1 (Chan-Jackson, Trang-Ikegami). *Assume AD and $\mathbb{P} \subseteq \mathbb{R}$ is a non-trivial*

forcing. Then whenever $g \subset \mathbb{P}$ is V -generic, $V[g] \models \neg\text{AD}$.

This result in some sense is optimal. There are examples of forcings that preserve AD. Regarding question (2), an analogous statement to the famous Kunen's theorem for models of ZFC, can be shown: suppose $V = L(X)$ for some set X and $V \models \text{AD}$, then there is no non-trivial elementary embedding from V to itself. Time permitted, we will discuss several related questions. This is joint work with D. Ikegami.

**Abstracts of invited talks in the Special Session on
Women in the History of Logic**

- ▶ LONDON D.C. ELKIND, *Tarski's and Wrinch's work on equivalents of Choice, Russell's different reactions to them.*

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Tarski's work on equivalents of Choice is well-known. Wrinch's work on equivalents of Choice is not. Russell gave prominence to Tarski's work by listing it among the "contributions to mathematical logic" since the publication of *Principia*'s first edition. Wrinch's work did not make Russell's list. This is curious since Russell was Wrinch's *de facto* thesis supervisor (Hardy was the *de jure* one) and since Wrinch's work, unlike Tarski's, more closely adhered to the system and style of *Principia*.

In this paper we explain why Wrinch's work did not make the list. We review the slice of Tarski's work that Russell listed in *Principia*'s second edition. Then we explain what Wrinch intended to prove, that the non-existence of mediate cardinals is equivalent to Choice. We explain why Wrinch's definitions are ill-typed in *Principia*'s system. This gives some rationale for Russell's decision to omit citation of Wrinch's work. We finally discuss repairs that salvage her theorem consistent with *Principia*'s type restrictions.

- ▶ FREDERIQUE JANSSEN-LAURET, *Ruth Barcan Marcus' contributions to modal logic.*

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In the mid-twentieth century, analytic philosophy took a sharp turn away from its previous strong adherence to descriptivism (Frege, Russell) and anti-modal extensionalism (Russell, Quine, early Carnap) and towards the direct-reference theory of names, the necessity of identity, and the many and varied applications of quantified logics of modality. All three had come into the analytic mainstream through the works of one woman, Ruth Barcan Marcus. But analytic philosophers now tend to credit all three to Kripke, or modal logic to Carnap and the others to Kripke (Ballarin, SEP 2021), or even modal logic to Carnap, necessary identity to Quine (Burgess, Synthese 2014). In this paper, I argue that Barcan Marcus' versions of these ideas were not inferior, but in fact superior, to Kripke's.

Ruth Barcan (later Ruth Barcan Marcus) published the first quantified modal logic in her mid-twenties, and proved the necessity of identity (Barcan, *J. Symb. Logic* 1946, 1947). Barcan approached quantified modal logic as a calculus, proof-theoretically. Her system therefore did not assume quantification over possible worlds, as in Kripke's now more common treatment, and her well-known Barcan Formula (really a schema) did not imply a possible-world model with constant domains as a result, although Barcan later considered such an interpretation (Barcan Marcus, *Synthese* 1961). I read Barcan's 1946-47 modal logic in the context of her wider philosophical views from the '60s, specifically the empiricist nominalism which also informed her arguments for taking

ordinary proper names' meanings to be just their bearers, not descriptions of their bearers (Barcan Marcus, *Synthese* 1961), which in turn informed her views on identity. I argue against Burgess' contention that Barcan did not prove the necessity of identity and that this proof is due to Quine. I further argue that Barcan Marcus's views are preferable to Kripke's in several respects. First, since she views modal discourse about actualia a counterfactual descriptions of actual objects, and modal discourse about possibilities as extensive but false Russellian descriptions, it is ontologically parsimonious. Barcan, whose strict nominalism led her to reject posits which could not be directly observed and named, thought possible worlds unpalatable. She conceived of modal calculi as allowing us to regiment counterfactual discourse about actual existents. Second, I argue that Barcan's account of necessity of identity according to which only directly referential names can flank the identity sign has its advantages over Kripke's 'rigid designation' account.

- ▶ TERESA KOURI KISSEL, *Susan Stebbing and the commonsense nature of modus ponens*.

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Over the course of her career, Susan Stebbing made a number of claims about which beliefs were commonsense, and how common sense helped us to develop notions of certain otherwise imprecise concepts. In this presentation, I will explore which aspects of logic, metaphysics and critical thinking she held to be commonsense truths. I will focus in particular on her claim that modus ponens, as a rule, must be a commonsense truth. This requires a specific interpretation of her views. Once we have this specific interpretation in hand, we can see better exactly what Stebbing's theory of common sense is. Stebbing's views of common sense influenced her academic and public philosophy, and we can learn from her on the topic.

- ▶ ANDREA REICHENBERGER, *From symbolic logic to computer science: Rózsa Péter's work on recursive functions and computability*.

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Rózsa Péter (1905–1977) is prominent as “founding mother” of recursion theory and contributing editor of the *Journal of Symbolic Logic*. This presentation is dedicated not only to Péter's early work on recursive functions in the 1930ies and 1940ies, but also on further developments and diverse applications in the newly establishing computer sciences. In particular, I will focus on Péter's “graphschemata,” i.e. a graphical representation of flow-charts used in programming, which later became known as “Kalužnin-Péter diagrams.” To be more precise, Péter considered a rather restricted type of diagram, “normalschemata,” as a possible candidate for the characterization of constructive functions. Although, at the end Péter considered this attempt to be a failed one, that's not the end of the story. With her work on “graphschemata,” Péter laid a cornerstone for computability by diagrams, to establish a hierarchy of recursive functions according to the complexity of their diagrams. Today it is well-known that computability by flowcharts is not equivalent to computability by recursive programs; nevertheless, for some programming purposes computability by flowcharts fits very well.

[1] E. MORRIS AND L. HARKLEROAD, *Rózsa Péter: Recursive function theory's founding mother*, *The Mathematical Intelligencer*, vol. 12, no. 1, 1990, pp. 59–61.

[2] R. PÉTER, *Graphschemata und rekursive Funktionen*, *Dialectica*, vol. 12, no. 3–4, 1958, pp. 373–393.

[3] R. PÉTER, *Rekursive Funktionen*, Akadémiai Kiadó, 1951.

[4] R. PÉTER, *Rekursive Funktionen in der Komputer Theorie*, Akadémiai Kiadó, 1976.

- GISELE DALVA SECCO, *Loparić avec les lacaniens: notes on a translation*.

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Andrea Loparić (1941–2021) was a logician who educated generations of Brazilian philosophers, contributed to the consolidation of the Brazilian logic community, and played a significant role in the early developments of non-classical logic. Andrea was also a prominent activist of the Brazilian left around the time of the country's civil-military dictatorship. While an undergraduate student, she collaborated in the conception of a nationwide socialist political organization, the *Ação Popular*, until her departure for Europe in 1961. At the Catholic University of Louvain, she got a second bachelor's degree and a master's degree in philosophy with a dissertation on the meaning of history according to Merleau-Ponty (1964). Since her youth until the last year of her life, Andrea was passionately engaged in politically relevant dialogs and actions (having created a pioneering internet service by the end of the 1990s, more in [5]).

One of Loparić's most important results in logic was a semantics for minimal, or positive intuitionistic logic (PIL). Since Da Costa's C_ω -logic is an extension of PIL, determining a semantics for minimal logic was crucial. Using her previously developed theory of valuations, Loparić showed in [2] that systems admitting formal inconsistency without trivialization are correct and complete; applying her methods, she also proved the decidability of Da Costa and Arruda's paraconsistent calculus. Among her last ongoing projects was a book celebrating her 80th birthday [4] - a selection of her logical papers plus an unpublished interview with her friend of colleague Ítala D'Ottaviano (flawlessly entitled "Diálogos sobre Lógica, Filosofia e Justiça").

My contribution to this symposium is a commentary on a rather curious text in Loparić's corpus that I am currently translating from French into both English and Portuguese - and that does not appear in the book organized in her honor. In [3], the result of her contribution to the conference *Lacan avec les philosophes*, Loparić shows that the famous and widely misunderstood "formulae of sexuation" proposed by Jacques Lacan in [1] can be given a strictly logical reading. By means of semantics for non-classical predicate calculus in which identity and quantification are defined alternatively and the notions of interpretation and satisfiability are more generally defined, Loparić makes Lacan's formulae logically readable in a kind of imaginative exercise that only a fervid logical mind can perform.

[1] J. LACAN AND J.-A. MILLER, *Le séminaire de Jacques Lacan, Livre XX Encore: 1972–1973*, Éditions du Seuil, Paris, 1975.

[2] A. LOPARIĆ, *A semantical study of some propositional calculi*, *Journal of Non-Classical Logic*, vol. 3 (1986), no. 1, pp. 73–95.

[3] A. LOPARIC *Les négations et les univers de discours*, *Lacan avec les philosophes*, Éditions du Albin Michel, Paris, 1991.

[4] A. RODRIGUES, C. MORTARI, E. PIMENTEL, AND G.D. SECCO, *Selected papers in honor of Andrea Maria Altino de Campos Loparić*, Coleção CLE, Unicamp, forthcoming.

[5] G.D. SECCO, *Rede Brasileira de Mulheres Filósofas Andrea Loparić*, Filósofas Brasileiras, youtube video.

- SARA L. UCKELMAN, *What problem did Ladd-Franklin (think she) solve(d)?*

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Christine Ladd-Franklin is often hailed as a guiding star in the history of women in logic—not only did she study under C.S. Peirce and was one of the first women to receive a PhD from Johns Hopkins, she also, according to many modern commentators, solved a logical problem which had plagued the field of syllogisms since Aristotle. In this paper, we revisit this claim, posing and answering two distinct questions: Which logical problem did Ladd-Franklin solve in her thesis, and which problem did she *think* she solved? We show that in neither case is the answer ‘a long-standing problem due to Aristotle’. Instead, what Ladd-Franklin solved was a problem due to Jevons that was first articulated in the 19th century.

Abstracts of contributed talks

- ▶ WILLIAM ADKISSON, *The strong tree property and ITP.*

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The tree property is an analogue of König’s Lemma for uncountable trees. An inaccessible cardinal is weakly compact if and only if it has the tree property; in this way, the tree property characterizes weak compactness up to inaccessibility. The strong tree property and ITP (also called the super tree property) are generalizations of the tree property that characterize strong compactness and supercompactness in much the same way. That is, an inaccessible cardinal κ is strongly compact if and only if the strong tree property holds at κ , and supercompact if and only if ITP holds at κ . Generalizing a result of Neeman about the tree property, we show that it is consistent for ITP to hold at \aleph_n for $2 \leq n < \omega$ and the strong tree property to hold at $\aleph_{\omega+1}$ simultaneously. This answers a question of Fontanella. We also show that it is consistent for ITP to hold at \aleph_n for $4 \leq n < \omega$ and at $\aleph_{\omega+1}$ simultaneously. Finally, we examine the situation at successors of singulars of uncountable cofinality.

- ▶ MICHAŁ TOMASZ GODZISZEWSKI, *Tennenbaum’s Theorem for quotient presentations of nonstandard models of arithmetic.*

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A computable quotient presentation of a mathematical structure \mathcal{A} consists of a computable structure on the natural numbers $\langle \mathbb{N}, \star, *, \dots \rangle$, meaning that the operations and relations of the structure are computable, and an equivalence relation E on \mathbb{N} , not necessarily computable but which is a congruence with respect to this structure, such that the quotient $\langle \mathbb{N}, \star, *, \dots \rangle$ is isomorphic to the given structure \mathcal{A} . Thus, one may consider computable quotient presentations of graphs, groups, orders, rings and so on. A natural question asked by B. Khoussainov in 2016, is if the Tennenbaum Theorem extends to the context of computable presentations of nonstandard models of arithmetic. In a joint work with J.D. Hamkins we have proved that no nonstandard model of arithmetic admits a computable quotient presentation by a computably enumerable equivalence relation on the natural numbers. However, as it happens, there exists a nonstandard model of arithmetic admitting a computable quotient presentation by a co-c.e. equivalence relation. Actually, there are infinitely many of those. The idea of the proof consists in simulating the Henkin construction via finite injury priority argument. What is quite surprising, the construction works (i.e. injury lemma holds) by Hilbert’s Basis Theorem. The latter argument is joint work with T. Slaman and L. Harrington.

- ▶ DAVID GONZALEZ, *The ω -Vaught's conjecture*.
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Robert Vaught conjectured that the number of countable models of any given list of axioms must be either countable or continuum, but never in between. Despite all the work that has gone into this conjecture over the past sixty years, it remains open. It is one of the most well-known, long-standing open questions in mathematical logic. We introduce the ω -Vaught's conjecture, a strengthening of Vaught's conjecture for infinitary logic. We believe that a structural proof of Vaught's conjecture for infinitary logic would actually be a proof of the ω -Vaught's conjecture. Furthermore, a counterexample to the ω -Vaught's conjecture would likely contain ideas helpful in constructing a counterexample to Vaught's conjecture.

We prove the ω -Vaught's conjecture for linear orderings, a strengthening of Vaught's conjecture for linear orderings originally proved by Steel [1]. The proof notably differs from Steel's proof (and any other previously known proof of Vaught's conjecture for linear orderings) in that it makes no appeal to lemmas from computability theory or descriptive set theory.

This talk is based on joint work with Antonio Montalbán.

[1] JOHN R. STEEL, *On Vaught's conjecture*, **Cabal Seminar 76–77** (Proceedings, Caltech-UCLA Logic Seminar, 1976–77), (Alexander S. Kechris and Yiannis N. Moskova, editors), Lecture Notes in Mathematics, vol. 689, Springer, 1978, pp. 193–208.

- ▶ OWAIN GRIFFIN, *Skepticism, Skolemism, and the standard model*.
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Model theory has provided a wealth of resources which have contributed to some of the twentieth century's most interesting philosophical debates. In particular, following the groundbreaking theorem of Löwenheim and Skolem, philosophers and logicians began to question their grasp of supposedly fundamental mathematical notions, leading to a new skeptical challenge known as 'Skolemism'.

In the contemporary scene, there is a general consensus that such model-theoretic skeptical challenges are incoherent. In this paper, I wish to challenge the orthodoxy, and argue that there is an internally coherent skeptical challenge to be posed, which cannot be as easily dismissed as has been supposed. In particular, I will question the notion of 'The Standard Model' of arithmetic, and argue that the distinction between standard and non-standard models is dependent upon one's starting perspective. This suggests a connection to some perspectivalist accounts proposed in the philosophy of science, which would allow the skeptical challenge to be formulated in a coherent, and non-self undermining way.

- ▶ SAMSON LEUNG, *First stability cardinals of AECs*.
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Let \mathbf{K} be an abstract elementary class (AEC) and $\lambda = \text{LS}(\mathbf{K})$. We show that $\beth_{(2^\lambda)^+}$ is the lower bound to the Hanf numbers for the length of the order property and for stability in stable AECs. Our examples satisfy the joint embedding property, no maximal models, and ($< \aleph_0$)-tameness but not necessarily the amalgamation property. This contrasts with Vasey's upper bound $\beth_{(2^\lambda)^+}$, but assuming tameness and amalgamation.

- ▶ PEDRO E. MARUN, *Subtrees with small branching number*.
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Given a tree T , we can view a branch through T as a subtree which is 1-branching, i.e. each point on the branch has exactly one immediate successor on the branch. This point of view allows us to generalize the tree property by asking whether a tree can have tall subtrees with small branching number. In particular, we can ask whether an Aronszajn tree can have finitely branching subtrees of height \aleph_1 . This leads to a non-empty class of trees which is strictly between those of Suslin and Aronszajn trees, provably in ZFC. In addition, such trees can be characterized as those having the Lindelöf property with respect to a reasonably nice topology.

- ▶ RUSSELL MILLER, *Computability and the absolute Galois group of \mathbb{Q}* .
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Fix a computable presentation $\overline{\mathbb{Q}}$ of the algebraic closure of the field \mathbb{Q} of rational numbers. With such a presentation, the automorphisms of $\overline{\mathbb{Q}}$ are naturally given as paths through a strongly computable finite-branching tree. The operations of composition and inversion on these automorphisms (i.e., on these paths) are both type-2 computable. Thus we have an effective way of considering $\text{Aut}(\overline{\mathbb{Q}})$, the absolute Galois group of \mathbb{Q} .

This group $\text{Aut}(\overline{\mathbb{Q}})$ has subgroups $G_{\mathbf{d}} = \{\text{all } \mathbf{d}\text{-computable } \alpha \in \text{Aut}(\overline{\mathbb{Q}})\}$ defined by each Turing degree \mathbf{d} , and it is natural to ask how close they come to being elementary subgroups of $\text{Aut}(\overline{\mathbb{Q}})$. We will give two low Turing degrees \mathbf{c} and \mathbf{d} such that the subgroup $G_{\mathbf{c}} \cap G_{\mathbf{d}}$ is elementary for existential and universal formulas and also for all *positive formulas* (i.e., those not using the negation connective). It remains open whether this result can be extended to all formulas, and also whether it can hold of a single subgroup of the form $G_{\mathbf{d}}$, rather than an intersection. These ideas, connected to certain basic reverse-mathematical principles, give rise to intriguing number-theoretical questions about $\text{Aut}(\overline{\mathbb{Q}})$.

- ▶ S. KAAK TABAKCI, *Tonk in metainferences*.
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The problematic connective **tonk** was introduced by [7] to demonstrate that solely stipulating sets of inference rules is not sufficient for a logical operator to be meaningful. Following [2], we can diagnose the problem caused by **tonk** in terms of the incompatibility of its inference rules and the antecedently given *Tarskian* context of deducibility. This diagnosis naturally gives rise to approaches where **tonk** is argued to be meaningful in appropriate non-Tarskian contexts of deducibility, such as non-transitive ones as in [3] and [8] or both non-transitive and non-reflexive ones such as in [5].

Furthermore, as argued by [1] and [4] non-Tarskian logics mentioned above are demarcated better by their *metainferences*. In this paper, we will analyze **tonk** in the non-Tarskian contexts of deducibility within a proof system where metainferences are the objects that are manipulated by rules of inference. (See [6].) This will require us to define what it means for a connective to *metainferentially* exist and be *metainferentially* unique, and this will open a number of ways **tonk** rules can be formulated depending on their premise-sequent and conclusion-sequent rules. We will argue that there are only two serious and equally acceptable candidates among them to legitimately define **tonk**.

We will show that for one of the candidates, we can provide metainferential uniqueness and existence results when the context of deducibility is both non-transitive and non-reflexive, and we can provide a four valued truth-functional semantics similar to the one discussed in [5] to interpret it. However, the other candidate, although *metainferentially* unique, does not *metainferentially* exist in any common non-Tarskian context of deducibility; hence, it is subject to the original problem of **tonk** introduced by [7].

[1] EDUARDO BARRIO, LUCAS ROSENBLATT AND DIEGO TAJER, *The Logics of Strict-Tolerant Logic*, **Journal of Philosophical Logic**, vol. 44 (2015), no. 5, pp. 551-571.

[2] NUEL D. BELNAP, *Tonk Plonk and Plink*, **Analysis**, vol. 2 (1962), no. 6, pp. 130-134.

[3] ROY T. COOK, *What's Wrong with Tonk*, **Journal of Philosophical Logic**, vol. 34 (2005), no. 2, pp. 217-226.

[4] BOGDAN DICHER AND FRANCESCO PAOLI, *ST, LP and Tolerant Metainferences, Graham Priest on Dialetheism and Paraconsistency* (Can Başkent and Thomas Macaulay Ferguson, editors), Springer, 2020, pp. 383-407

[5] ANDREAS FJELLSTAD, *How a semantics of tonk should be*, **The Review of Symbolic Logic**, vol. 8 (2015), no. 3, pp. 488-505.

[6] ROHAN FRENCH, *Metasequents and Tetravaluations*, **Journal of Philosophical Logic**, vol. 50 (2021), pp. 493-498.

[7] ARTHUR PRIOR, *The Runabout Inference Ticket*, **Analysis**, vol. 21 (1967), no. 2, pp. 38-39.

[8] DAVID RIPLEY, *Anything Goes*, **Topoi**, vol. 34 (2014), no. 1, pp. 25-36.

► HENRY TOWNSNER, *What is tame hypergraph regularity?*

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Important model theoretic dividing lines like stable and NIP are known to be equivalent to certain strengthenings of Szemerédi's Regularity Lemma: stable and NIP relations have certain kinds of approximations by rectangles. The goal of tame hypergraph regularity is to identify dividing lines for ternary and higher arity relations by characterizing which relations have various kinds of approximations by higher arity generalizations of rectangles (called "cylinder intersection sets" or "simplices" in different contexts).

In this talk, I will summarize the current state of the area in light of recent results by Chernikov and Towsner and by Terry and Wolf.

► KAMERYN WILLIAMS, *Non-tightness in class theory.*

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A theory T is tight if different deductively closed extensions of T (in the same language) cannot be bi-interpretable. Enayat showed that ZF and KM (the Kelley–Morse theory of classes with full comprehension) are tight. A question was then, is the full strength of these theories necessary for this result? In this talk I will provide evidence toward a positive answer for the case of KM. Namely, GB (the Gödel–Bernays theory of classes with only predicative comprehension) and the restriction of KM to Σ_k^1 -Comprehension, for any k , all fail to be tight. The main idea of the construction is that minimal models of these theories are bi-interpretable with extensions by a carefully chosen Cohen generic class of ordinals.

This talk is about joint work with Alfredo Roque Freire.

- WENTAO YANG, *An NIP-like notion for abstract elementary classes*.
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We propose an analogue definition of No Independence Property (NIP) for abstract elementary classes (AECs) that coincides with NIP in first order model theory, where the class is elementary. As we have no formulas in this context we work with Galois types. We construct a forking-like relation on AECs with NIP. Our work can be viewed as a new chapter in the neo-stability of AECs, building on Armida-Mazari's work [1].

[1] MARCOS MAZARI-ARMIDA, *Non-forking w -good frames*, *Archive for Mathematical Logic*, vol. 59 (2020), no. 1–2, pp. 31–56.

Abstracts of talks presented by title

- JOACHIM MUELLER-THEYS, *Propositional precursors of Named Model Theory*.
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I. $L_{PL} ::= p \mid \neg\phi \mid \phi \wedge \psi$. $\mathcal{I}(p) \in \{0, 1\}$. $\mathcal{I} \models p$:iff $\mathcal{I}(p) = 1$, $\mathcal{I} \models \neg\phi$:iff $\mathcal{I} \not\models \phi$, $\mathcal{I} \models \phi \wedge \psi$:iff $\mathcal{I} \models \phi, \psi$. $\mathcal{I} \models \Phi$:iff $\mathcal{I} \models \phi$ for all $\phi \in \Phi \subseteq L_{PL}$. $\mathcal{I} \equiv \mathcal{J}$:iff for all ϕ : $\mathcal{I} \models \phi$ iff $\mathcal{J} \models \phi$. We call $Th(\mathcal{I}) := \{\phi : \mathcal{I} \models \phi\}$ the *theory* of \mathcal{I} . $\mathcal{I} \equiv \mathcal{J}$ iff $Th(\mathcal{I}) = Th(\mathcal{J})$. $\Phi \models \phi$:iff for all \mathcal{I} : $\mathcal{I} \models \Phi$ implies $\mathcal{I} \models \phi$.

$\mathcal{I} \sqsubseteq_{at} \mathcal{J}$:iff \mathcal{J} satisfies all atoms \mathcal{I} satisfies; $\mathcal{I} \equiv_{at} \mathcal{J}$:iff $\mathcal{I} \sqsubseteq_{at} \mathcal{J}$, $\mathcal{J} \sqsubseteq_{at} \mathcal{I}$. *Atomic entailment and equivalence characterize $\mathcal{I} \leq \mathcal{J}$ and $\mathcal{I} = \mathcal{J}$ respectively*. By the latter, $\mathcal{I} = \mathcal{J}$, $\mathcal{I} \equiv \mathcal{J}$, $\mathcal{I} \equiv_{at} \mathcal{J}$ are equivalent, and \mathcal{I} may be identified with its atomic theory.

The *basic theory* $Th_{bas}(\mathcal{I})$ consist from all atoms and negated atoms \mathcal{I} satisfies. $\mathcal{I} \sqsubseteq_{bas} \mathcal{J}$ iff $Th_{bas}(\mathcal{I}) \subseteq Th_{bas}(\mathcal{J})$. We have shown that $\mathcal{I} \sqsubseteq_{bas} \mathcal{J}$ iff $\mathcal{I} \equiv_{at} \mathcal{J}$, whence $\mathcal{I} \sqsubseteq_{bas} \mathcal{J}$ implies $\mathcal{I} = \mathcal{J}$.

Any interpretation is completely axiomatized by its basic theory: Obviously, $\mathcal{I} \models Th_{bas}(\mathcal{I})$ and $\mathcal{J} \models Th_{bas}(\mathcal{I})$ implies $\mathcal{I} \sqsubseteq_{bas} \mathcal{J}$. Thence, $Th_{bas}(\mathcal{I}) \models \phi$ if and only if $\mathcal{I} \models \phi$. If \vdash is some sound and complete derivability, $Th_{bas}(\mathcal{I}) \vdash \phi$ iff $\mathcal{I} \models \phi$.

II. Let L be any first-order language. We call a L -structure \mathcal{M} (*completely*) *named* :iff for all $a \in |\mathcal{M}|$ there is some closed L -term t such that $a = t^{\mathcal{M}}$, where $t^{\mathcal{M}}$ be the interpretation of t by \mathcal{M} . For example, $(\text{IN}, 0, ')$ is named.

Namedness allows for striking model-theoretic characterizations of the morphisms: *Let \mathcal{M} be named and $\mathcal{M} \sqsubseteq_{at} \mathcal{N}$. Then \mathcal{M} is (weakly) homomorphic to \mathcal{N}* , viz. $\beta[c^{\mathcal{M}}] = c^{\mathcal{N}}$, $\beta[f^{\mathcal{M}}(\vec{a})] = f^{\mathcal{N}}(\beta[\vec{a}])$; $\vec{a} \in P^{\mathcal{M}}$ implies $\beta[\vec{a}] \in P^{\mathcal{N}}$. \sqsubseteq_{at} now ranges over atomic L -sentences. *If \mathcal{N} is named too and $\mathcal{M} \equiv_{at} \mathcal{N}$, $\mathcal{M} \cong \mathcal{N}$* , whence $\mathcal{M} \cong \mathcal{N}$, $\mathcal{M} \equiv \mathcal{N}$, $\mathcal{M} \equiv_{at} \mathcal{N}$ are equivalent. Major tool are *Buchholz correspondences* $\beta[t^{\mathcal{M}}] := t^{\mathcal{N}}$. Results for the other morphisms may be obtained *mutatis mutandis*.

For named structures \mathcal{M} , we achieve *named axiomatization*: $Th_{bas}(\mathcal{M}) \models \sigma$ if and only if $\mathcal{M} \models \sigma$, whereby $\Sigma \models \sigma$:iff $\Sigma \models \sigma$ for named models.

Since any L -structure \mathcal{M} has some named \hat{L} -expansion $\hat{\mathcal{M}}$, we obtain a *General Axiomatization Theorem*: $Th_{bas}(\hat{\mathcal{M}}) \models \sigma$ if and only if $\mathcal{M} \models \sigma$.

References: “Named Model Theory”, The Bulletin of Symbolic Logic 27 (2021), pp. 105-6; “The idea of Named Logic”, The Bulletin of Symbolic Logic 26 (2020), pp. 197-8.