BRIN MATHEMATICS RESEARCH CENTER

Logic at Maryland

August 26-30, 2024

About the workshop

Logic at Maryland is an event dedicated to nurturing national and international collaborations in mathematical logic and its interactions with dynamics, combinatorics, and geometric group theory. Emphasizing the vibrant intersections of these disciplines, this workshop aims to stimulate growth and activity within and around the Maryland Logic Group while showcasing the burgeoning logic community at the University of Maryland.

Organizers

Artem Chernikov, University of Maryland
Chris Laskowski, University of Maryland
Christian Rosendal, University of Maryland
Jenna Zomback, University of Maryland

Speakers and Participants

John Baldwin, University of Illinois at Chicago
Anton Bernshteyn, Georgia Institute of Technology
Ilijas Farah, York University
Valentina Harizanov, The George Washington University
Itay Kaplan, The Hebrew University of Jerusalem
Alexander Kechris, California Institute of Technology
David Marker, University of Illinois at Chicago
Amador Martin-Pizarro, University of Freiburg
Rahim Moosa, University of Waterloo
Ludomir Newelski, University of Wroclaw
Alf Onshuus, Universidad de los Andes
Anand Pillay, University of Notre Dame
Emily Riehl, Johns Hopkins University
Marcin Sabok, McGill University
Slawomir Solecki, Cornell University
Sergei Starchenko, University of Notre Dame
Katrin Tent, Universitat Munster
Simon Thomas, Rutgers University
Asger Törnquist, University of Copenhagen
Henry Towsner, University of Pennsylvania
Todor Tsankov, Universite Claude Bernard
Spencer Unger, University of Toronto
Julia Wolf, University of Cambridge
Carol Wood, Wesleyan University

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DEPARTMENT OF MATHEMATICS

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Program & abstracts

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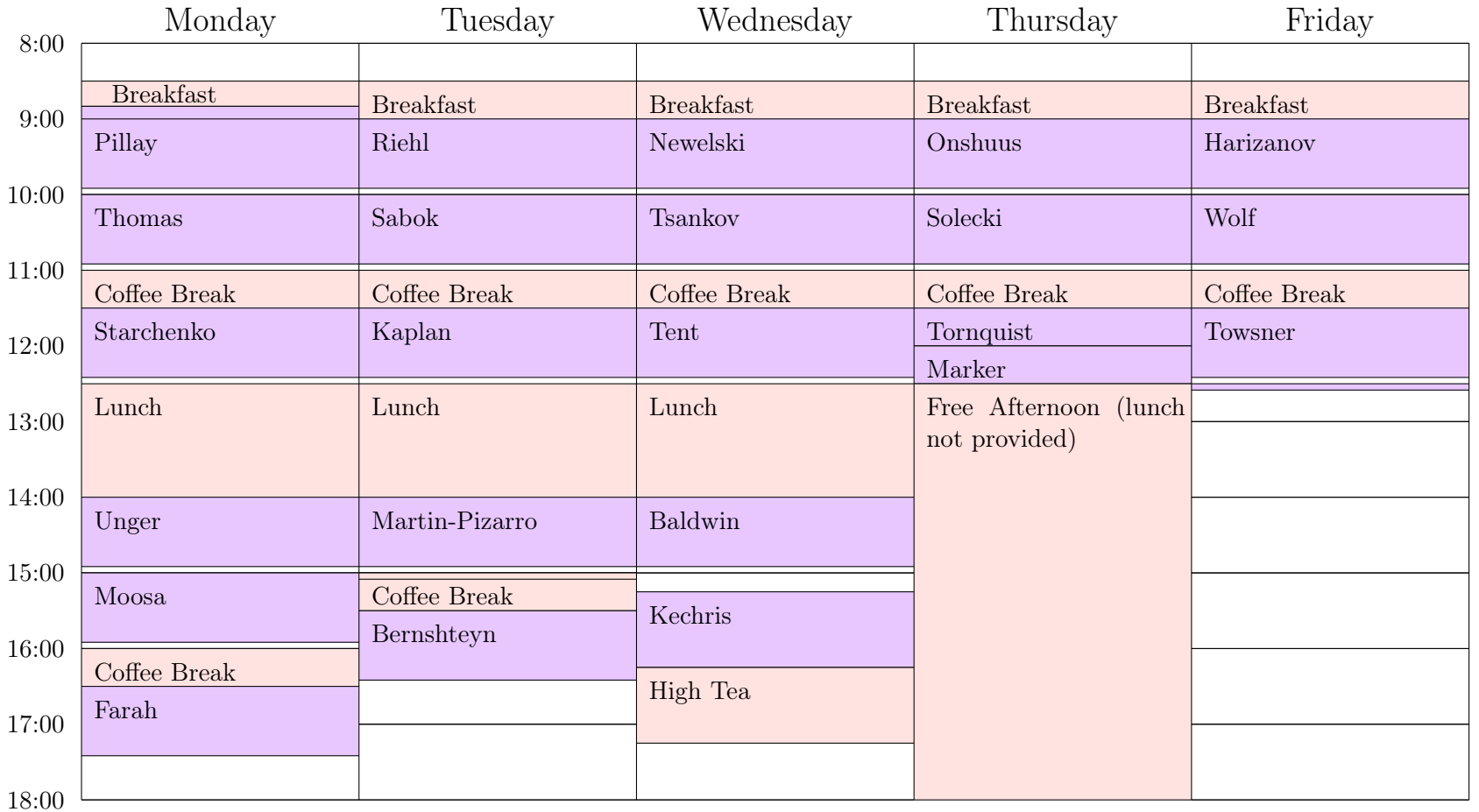

Workshop Overview

Logic at Maryland is an event dedicated to nurturing national and international collaborations in mathematical logic and its interactions with dynamics, combinatorics, and geometric group theory. Emphasizing the vibrant intersections of these disciplines, this workshop aims to stimulate growth and activity within and around the Maryland Logic Group while showcasing the burgeoning logic community at the University of Maryland. The conference will include invited talks by distinguished experts, illuminating the intersections of mathematical logic with neighboring fields, offering insights into current research trends and inspiring future directions of study.

Organizing committee

Artem Chernikov, University of Maryland

Chris Laskowski, University of Maryland

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Workshop Schedule

Monday, August 26, 2024

8:30 - 8:50 Breakfast

8:50 - 9:00 Doron Levy (University of Maryland/Director, Brin MRC)
Opening

9:00 - 9:55 Anand Pillay (University of Notre Dame)
An Analytic (Functional) Version of Stable Arithmetic Regularity. (Joint with Gabe Conant.)

10:00 - 10:55 Simon Thomas (Rutgers University)
The Complexity of the Quasi-Isometry Relation for Finitely Generated Groups

11:00 - 11:30 Coffee Break

11:30 - 12:25 Sergei Starchenko (University of Notre Dame)
A Generalization of Elekes-Szabo theorem

12:30 - 2:00 Lunch

2:00 - 2:55 Spencer Unger (University of Toronto)
Equidecomposition with Algebraic Irrationals

3:00 - 3:55 Rahim Moosa (University of Waterloo)
Binding Groups for Algebraic Dynamics

4:00 - 4:30 Coffee Break

4:30 - 5:25 Ilijas Farah (York University)
Rigidity of Reduced Products

Tuesday, August 27, 2024

8:30 - 9:00 Breakfast

9:00 - 9:55 Emily Riehl (Johns Hopkins University)
A Reintroduction to Proofs

10:00 - 10:55 Marcin Sabok (McGill University)
Conjugacy of Transitive Systems and Bowen's Problem 32

11:00 - 11:30 Coffee Break

11:30 - 12:25 Itay Kaplan (The Hebrew University of Jerusalem)
On NIP Cofinal Families of Subsets

12:30 - 2:00 Lunch

2:00 - 2:55 Amador Martin-Pizarro (University of Freiburg)
Corners, Squares and Stability

3:00 - 3:30 Coffee Break

3:00 - 3:05 Group Photo

3:30 - 4:25 Anton Bernshteyn (University of California, Los Angeles)
Embedding Borel Graphs into Grids

Wednesday, August 28, 2024

8:30 - 9:00 Breakfast

9:00 - 9:55 Ludomir Newelski (University of Wroclaw)
Uniformly Strongly Generic Sets and Ellis Groups

10:00 - 10:55 Todor Tsankov (Universite Claude Bernard)
Affine Logic and Integral Decomposition

11:00 - 11:30 Coffee Break

11:30 - 12:25 Katrin Tent (Universitat Munster)
From Cherlin-Zilber to the Burnside Problem

12:30 - 2:00 Lunch

2:00 - 2:55 John Baldwin (University of Illinois at Chicago)
When is an $\aleph_1$ categorical $L_{\omega_1,\omega}$-sentence ω-stable

3:15 - 4:15 Alexander Kechris (California Institute of Technology)
Brin MRC Distinguished Lecture Orbit Equivalence Relations and the Compact Action Realization Problem

4:15 - 5:15 High Tea

Thursday, August 29, 2024

8:30 - 9:00 Breakfast

9:00 - 9:55 Alf Onshuus (Universidad de los Andes)
Lie Groups and O-Minimality

10:00 - 10:55 Slawomir Solecki (Cornell University)
Topological Groups Without Unitary Representations, Submeasures, and the Escape Property

11:00 - 11:30 Coffee Break

11:30 - 12:00 Asger Tornquist (University of Copenhagen)
Regularity Properties and Maximal Discrete Objects in Descriptive Set Theory

12:00 - 12:30 David Marker (University of Illinois at Chicago)
Rigid Real Closed Fields

12:30 - 6:00 Free Afternoon (lunch not provided)

7:00 - 9:00 Conference Dinner

Friday, August 30, 2024

8:30 - 9:00 Breakfast

9:00 - 9:55 Valentina Harizanov (George Washington University)
Computability-Theoretic Variant of the Ultraproduct Construction

10:00 - 10:55 Julia Wolf (University of Cambridge)
The Structure of Sets of Bounded VC_2-Dimension Revisited

11:00 - 11:30 Coffee Break

11:30 - 12:25 Henry Towsner (University of Pennsylvania)
Fast and Faster Growing Functions

12:30 - 12:35 Workshop Closing

Abstracts of talks

An Analytic (Functional) Version of Stable Arithmetic Regularity. (Joint with Gabe Conant.)

Anand Pillay

University of Notre Dame

Monday, August 26, 2024 @ 9:00 AM

If G is a group, a function f from G to $[-1, 1]$ is called stable if the function f(x.y) from $G \times G$ to $[-1, 1]$ is stable in the sense of continuous logic. We give a structure theorem for stable functions on amenable groups (extending the arithmetic regularity lemma for stable subsets of finite groups). The ubiquity of stable functions on groups yields several applications.

The Complexity of the Quasi-Isometry Relation for Finitely Generated Groups

Simon Thomas

Rutgers University

Monday, August 26, 2024 @ 10:00 AM

It is clear that the quasi-isometry problem for finitely generated groups is much harder than the isomorphism problem. Using the language of Borel equivalence relations, I will conjecturally explain precisely how much harder; and I will discuss some of the many open questions in this area.

A Generalization of Elekes-Szabo theorem

Sergei Starchenko

University of Notre Dame

Monday, August 26, 2024 @ 11:30 AM

According to a theorem of Elekes and Szabo, the intersections of a given algebraic surface with finite grids may have maximal size only for varieties that are closely related to algebraic groups. In this talk, we provide a generalization of the earlier result by Chernikov-Peterzil-Starchenko to arbitrary co-dimension, in particular obtaining explicit bounds in a theorem due to Bays and Breuillard, and also answer their question about non-isogeneous groups. This is joint work with A. Chernikov and Y. Peterzil.

Equidecomposition with Algebraic Irrationals

Spencer Unger

University of Toronto

Monday, August 26, 2024 @ 2:00 PM

We answer a 1990 question of Laczkovich by showing that the circle and the square are equidecomposible by translations whose coordinates are algebraic irrationals. More generally we show that all known positive results about equidecomposition are possible with these translations. The use of algebraic irrationals allows us to explicitly compute some bounds on discrepancy used in the proof and leads to a reduction in the number of pieces required for a positive answer to Tarski's circle squaring question. This is joint work with Andrew Marks.

Binding Groups for Algebraic Dynamics

Rahim Moosa

University of Waterloo

Monday, August 26, 2024 @ 3:00 PM

I will describe a binding group theorem in the context of quantifier-free internality to the fixed field in the theory ACFA, with applications to the birational geometry of algebraic dynamical systems. This is joint work with Moshe Kamensky.

Rigidity of Reduced Products

Ilijas Farah

York University

Monday, August 26, 2024 @ 4:30 PM

By a seminal result of W. Rudin and S. Shelah, the assertion that all automorphisms of the Boolean algebra P(N)/Fin are 'trivial' (that is, lift to endomorphisms of P(N)) is independent from ZFC. I will discuss a question that is trivialized when all automorphisms of P(N)/Fin are trivial (!). Two trivial automorphisms of P(N)/Fin are *potentially conjugate* if they are conjugate in some forcing extension with the same reals. (This is essentially equivalent to CH implying they are conjugate.) By a recent result of Will Brian, the unilateral shift is potentially conjugate with its inverse. The analysis of potential conjugacy uses model-theoretic analysis of the expansion of P(N)/Fin by an automorphism, on which this talk will concentrate. I will discuss saturation and model-completeness of these structures, give some information about computing their theories, and connect this to the question of isomorphism of ultraproducts of matrix algebras.
This is a joint work in progress with Will Brian and Saeed Ghasemi.

A Reintroduction to Proofs

Emily Riehl

Johns Hopkins University

Tuesday, August 27, 2024 @ 9:00 AM

An introduction to proofs course aims to teach how to write proofs informally in the language of set theory and classical logic. In this talk, I'll explore the alternate possibility of learning instead to write proofs informally in the language of dependent type theory. I'll argue that the intuitions suggested by this formal system are closer to the intuitions mathematicians have about their praxis. Furthermore, dependent type theory is the formal system used by many computer proof assistants both "under the hood" to verify the correctness of proofs and in the vernacular language with which they interact with the user. Thus, there is an opportunity to practice writing proofs in this formal system by interacting with computer proof assistants such as Coq or Lean. Equally, intuitions built from an early informal introduction to dependent type theory will make it easier for those who aspire to write computer formalized proofs later on.

Conjugacy of Transitive Systems and Bowen's Problem 32

Marcin Sabok

McGill University

Tuesday, August 27, 2024 @ 10:00 AM

The talk will be focused on the complexity of the conjugacy problems of various transitive systems. I will discuss a recent result saying that the topological conjugacy relation of symbolic systems with specification is not amenable, and in particular not smooth. This shows that the classification asked for in Rufus Bowen's Problem 32 is impossible with concrete invariants. I will also discuss the complexity of the conjugacy of pointed transitive systems. Along the way, we will see an answer to a question of Bruin and Vejnar by establishing that topological conjugacy relation of pointed transitive Hilbert cube systems is bi-reducible with a turbulent group action. This is joint work with K. Deka, D. Kwietniak and B.

On NIP Cofinal Families of Subsets

Itay Kaplan

The Hebrew University of Jerusalem

Tuesday, August 27, 2024 @ 11:30 AM

When can a cardinal kappa have a family of finite subsets which are cofinal and of bounded VC dimension? I will discuss this and related questions. This is joint work with Omer Ben-Neria and George Peterzil (based on previous work with Ben-Neria, Simon and Bays).

Corners, Squares and Stability

Amador Martin-Pizarro

University of Freiburg

Tuesday, August 27, 2024 @ 2:00 PM

Given an abelian group G, a corner is a a subset of pairs of the form (x,y),(x+d,y),(x,y+d) with d?0 non trivial. Ajtai and Szemeredi proved that, asymptotically, every dense subset S of Z/NZ×Z/NZ contains a corner. Shkredov gave a quantitative lower bound on the density of the subset S for particular finite abelian groups. In this talk, we will explain how model-theoretic conditions on the subset S, such as stability, imply the existence of corners and of other combinatorial configurations for (pseudo)-finite abelian groups.

Embedding Borel Graphs into Grids

Anton Bernshteyn

University of California, Los Angeles

Tuesday, August 27, 2024 @ 3:30 PM

In this talk I will discuss large-scale geometry of Borel graphs of polynomial growth. The main result I will present is the following: If G is a Borel graph all of whose finite subgraphs embed into $(\mathbb{Z}^d, \|\cdot\|_\infty)$, then G itself admits a Borel embedding into the Schreier graph of a free Borel action of $\mathbb{Z}^{O(d)}$. This is joint work with Jing Yu.

Uniformly Strongly Generic Sets and Ellis Groups

Ludomir Newelski

University of Wroclaw

Wednesday, August 28, 2024 @ 9:00 AM

Assume G is a group definable in a model M. We are interested in thetopological dynamics of the G-flow of external G-types over M. Is it of model-theoretic or set-theoretic nature? In particular, what happens to its Ellis group when we pass over to a *-elementary extension of M? I will recall some results on this problem and also present a new result, involving uniformly strongly generic (usg) sets. Such sets are also of independent interest. For example, it is not known if there is a non-periodic usg subset of the additive group of integers.

Affine Logic and Integral Decomposition

Todor Tsankov

Universite Claude Bernard

Wednesday, August 28, 2024 @ 10:00 AM

Affine logic is a fragment of continuous logic introduced by Bagheri, where one only has affine connectives: sum, multiplication by real scalars, and the constant formula 1. This allows to endow the type spaces with the structure of compact convex sets and study the extremal models: the structures that realize only extreme types. Of particular interest are the simplicial theories, all of whose type spaces are Choquet simplices. I will discuss an integral decomposition result for models of simplicial theories into extremal models that generalizes both the ergodic decomposition theorem and the decomposition into factors of tracial von Neumann algebras. We do not make any separability assumptions and the non-separable case of the theorem is new even in these two classical settings. This is joint work with Itai Ben Yaacov and Tomas Ibarlucia.

From Cherlin-Zilber to the Burnside Problem

Katrin Tent

Universitat Munster

Wednesday, August 28, 2024 @ 11:30 AM

The Cherlin-Zilber Conjecture states that any infinite simple group of finite Morley rank is an algebraic group over an algebraically closed field. I will explain how work on this conjecture naturally leads to the Burnside problem, namely the question whether any finitely generated group of bounded exponent is finite. I will then indicate the ideas behind our proof with Atkarskaya and Rips which gives the currently best known lower bound for the exponent for infinite Burnside groups.

When is an $\aleph_1$ categorical $L_{\omega_1,\omega}$-sentence ω-stable

John Baldwin

University of Illinois at Chicago

Wednesday, August 28, 2024 @ 2:00 PM

A first order theory is categorical in $\aleph_1$ iff it is ω-stable and has no two cardinal models; this characterization is easily seen to be absolute. Already in **?** Shelah had given an example of an $L_{\omega_1,\omega}(Q)$ sentence that was categorical under MA but not under $2^{\aleph_0} < 2^{\aleph_1}$. Whether there is a similar example for $L_{\omega_1,\omega}$ remains open. I review a series of works with Laskowski and Shelah addressing this issue

Brin MRC Distinguished Lecture Orbit Equivalence Relations and the Compact Action Realization Problem

Alexander Kechris

California Institute of Technology

Wednesday, August 28, 2024 @ 3:15 PM

The study of orbit equivalence relations induced by Borel actions of countable groups on Polish (separable completely metrizable) spaces, and their orbit spaces, has been a very active area of research for several decades in various fields of mathematics, including ergodic theory, operator algebras, geometric group theory, combinatorics, probability and descriptive set theory. Many results in this area have been obtained using ergodic (measure theoretic) methods. After giving a basic introduction to this theory, I will focus on a new direction of topological nature that deals with the problem of realizing orbit equivalence relations by continuous actions on compact metrizable spaces and in particular subshifts. This also leads to considering a natural universal space for such actions and equivalence relations via subshifts and originates the study in this space of various important classes, especially the so-called hyperfinite ones, which are those induced by actions of the group of integers. This is joint work with Josh Frisch, Forte Shinko and Zoltan Vidnyanszky.

Lie Groups and O-Minimality

Alf Onshuus

Universidad de los Andes

Thursday, August 29, 2024 @ 9:00 AM

It has been known for some time that any group definable in an o-minimal expansion of the real field can be endowed definably with the structure of a Lie group, and that any definable homomorphisms between definable groups is a Lie homomorphism (under the above mentioned Lie structure). In this talk we explore the converse: We will characterize when a Lie group has a Lie isomorphic group which is definable in an o-minimal expansion of the real field, when Lie isomorphisms between such definable groups is definable, and whether one can achieve a definable Lie analytic structure in any such definable group.

Topological Groups Without Unitary Representations, Submeasures, and the Escape Property

Slawomir Solecki

Cornell University

Thursday, August 29, 2024 @ 10:00 AM

We give new examples of topological groups that do not have non-trivial continuous unitary representations, the so-called exotic groups. We prove that all groups of the form $L^0(\phi, G)$, where ϕ is a pathological submeasure and G is a topological group, are exotic. This result extends, with a different proof, a theorem of Herer and Christensen on exoticness of $L^0(\phi, \mathbb{R})$ for ϕ pathological. In our arguments, we introduce the escape property, a geometric condition on a topological group, inspired by the solution to Hilbert's fifth problem and satisfied by all locally compact groups, all non-archimedean groups, and all Banach–Lie groups. Our key result involving the escape property asserts triviality of all continuous homomorphisms from $L^0(\phi, G)$ to $L^0(\mu, H)$, where ϕ is pathological, μ is a measure, G is a topological group, and H is a topological group with the escape property.

Regularity Properties and Maximal Discrete Objects in Descriptive Set Theory

Asger Tornquist

University of Copenhagen

Thursday, August 29, 2024 @ 11:30 AM

The descriptive set-theoretic properties of maximal families that are discrete with respect to some relation(s) – examples of which are such things as maximal almost disjoint families, maximal orthogonal families of Borel probability measures, or Hamel bases – have been studied extensively. One of the main themes of this type of investigation is to ask if the existence of some kind of maximal discrete object is compatible with descriptive set theoretic regularity properties. Classically, regularity here would mean Baire, Lebesgue, Ramsey measurability, but more exotic examples of measurability such as Sacks, Miller, Laver, and Silver measurability (etc.) that arise from forcing are also very interesting to consider.

Rigid Real Closed Fields

David Marker

University of Illinois at Chicago

Thursday, August 29, 2024 @ 12:00 PM

Shelah showed that it consistent that there are uncountable rigid non-archimedian real closed fields and, later, he and Mekler proved this in ZFC. Answering a question of Enayat, Charles Steinhorn and I show that there are countable rigid non-archimedianreal closed fields by constructing one of transcendence degree two.

Computability-Theoretic Variant of the Ultraproduct Construction

Valentina Harizanov

George Washington University

Friday, August 30, 2024 @ 9:00 AM

We consider a computability-theoretic product construction for an infinite uniformly computable sequence of structures, where the role of an ultrafilter is played by a cohesive set. A cohesive set is an infinite set of natural numbers that cannot be split into two infinite subsets by any computably enumerable (c.e.) set. The elements of the effective product are the equivalence classes of certain partial computable functions, which in the case of a co-c.e. cohesive set can be replaced by (total) computable functions. In particular, we investigate the isomorphism types of cohesive powers of a computable structure. Unlike many classical ultrapowers, effective powers are countable structures. It is possible for isomorphic computable structures to have non-elementarily equivalent effective powers over a fixed cohesive set. In general, effective powers preserve the first-order properties expressed only by sentences of lower levels of quantifier complexity. Additional decidability in the computable structure plays a significant role in increasing satisfiability of sentences in its effective power. For example, for a structure A with a computable elementary diagram, its effective power is elementarily equivalent to A. We will present a number of our recent collaborative results on effective products and powers. In fact, the idea for effective powers goes back to Skolem's construction of a countable nonstandard model of arithmetic.

References [1] R.D. Dimitrov and V. Harizanov, Countable nonstandard models: following Skolem's approach, in: *Handbook of the History and Philosophy of Mathematical Practice*, B. Sriraman, ed., Springer, 2024, pp. 1989-2009. [2] R. Dimitrov, V. Harizanov, A. Morozov, P. Shafer, A.A. Soskova and S.V. Vatev, On cohesive powers of linear orders, *Journal of Symbolic Logic* 88 (2023), pp. 947–1004. [3] V. Harizanov and K. Srinivasan, Cohesive powers of structures, *Archive for Mathematical Logic* (2024), pp. 679–702.

The Structure of Sets of Bounded VC_2-Dimension Revisited

Julia Wolf

University of Cambridge

Friday, August 30, 2024 @ 10:00 AM

In joint work with Caroline Terry, we showed that subsets of bounded VC_2-dimension in a finite elementary abelian p-group can be approximated by a union of quadratic "atoms", that is, simultaneous level sets of a bounded number of high-rank quadratic and a bounded number of linear forms. This generalizes prior work of Alon-Fox-Zhao, Sisask, and Conant-Pillay-Terry for subsets of bounded VC-dimension, and is analogous to joint work with Terry and qualitative results of Chernikov-Towsner in the setting of hypergraphs. In this talk, we give a new perspective on the proof and explore the quantitative aspects of the problem.

Fast and Faster Growing Functions

Henry Towsner

University of Pennsylvania

Friday, August 30, 2024 @ 11:30 AM

The fast-growing hierarchy is a family of functions on the natural numbers, corresponding to "iterating the previous function" over and over again. By extending this iteration process to countable ordinals (more precisely, to make this well-defined, computable presentations of ordinals), this process can be extended to define even faster functions; this means that trying to describe faster growing computable functions largely reduces to describing larger countable ordinals. The Veblen function can be viewed as a way of constructing larger ordinals by a similar iteration (where the successor corresponds to "take fixed-points of the previous function" instead of "iterate the previous function"). We describe how larger ordinals can be seen as repeating the step that took us from functions on the natural numbers to functions on ordinals. We describe how this process can be used to give a description of the Howard-Bachmann ordinal and then extended to describe the proof-theoretic ordinal of second order arithmetic.

The Brin Mathematics Research Center

The Brin Mathematics Research Center is a research center that sponsors activity in all areas of pure and applied mathematics and statistics. The Brin MRC was funded in 2022 through a generous gift from the Brin Family. The Brin MRC is part of the Department of Mathematics at the University of Maryland, College Park.

Activities sponsored by the Brin MRC include long programs, conferences and workshops, special lecture series, and summer schools. The Brin MRC provides ample opportunities for short-term and long-term visitors that are interested in interacting with the faculty at the University of Maryland and in experiencing the metropolitan Washington DC area.

The mission of the Brin MRC is to promote excellence in mathematical sciences. The Brin MRC is home to educational and research activities in all areas of mathematics. The Brin MRC provides opportunities to the global mathematical community to interact with researchers at the University of Maryland. The center allows the University of Maryland to expand and showcase its mathematics and statistics research excellence nationally and internationally.

List of Participants

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