Tianyuan Workshop on Definability and Computation

June 22-26, 2026

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	Beijing Time		Schedule	Location
Jun. 22	7:30-9:00		Breakfast	Hua Luogeng Lecture Hall
	AM	9:00-9:40	Philip Welch, University of Bristol Title: Higher Type ITTM recursion and Determinacy	
		9:40-10:00	Break	
		10:00-10:40	Alexander Melnikov, Victoria University of Wellington Title: Computable classification: the twilight zone	
		10:40-10:50	Break	
		10:50-11:30	Rizos Sklinos, Chinese Academy of Sciences Title: On the superstable part of the free group	
	12:00-13:00		Lunch	
	PM	14:00-15:30	Problem Session Chair: Yue Yang	
		15:30-16:00	Break	
		16:00-17:30	Problem Session Chair: Liuzhen Wu	
	17:30-19:00		Dinner	

Higher Type ITTM recursion and Determinacy

Philip Welch

University of Bristol

Abstract: We outline a theory of type 2 recursion for Infinite Time Turing Machines *à la Kleene*. We establish a connection between classical descriptive set theory and ittm theory, by calculating the complexity of its halting problem as exactly that of a complete $\Im\Sigma^0_3$ (or $G_{\dot{}}$) set. This mirrors exactly what Kleene, Moschovakis *et al.* achieved for Kleene's Type 2 recursion and Σ^0_1 (or Open) Determinacy.

We ascertain the least ordinal which is not generalised recursive in this sense, and its characterisation *via* a concept of *infinite nestings* in Gödel's constructible hierarchy. The results do not require large cardinal axioms, and are all provable within analysis.

Computable classification: the twilight zone

Alexander Melnikov

Victoria University of Wellington

Abstract: In my talk, I will present several results that use computability-theoretic tools to measure the complexity of classification problems in topology. I will focus on results whose complexity lies within the arithmetical hierarchy, yet which require many alternations of quantifiers to be properly described. These include joint work with several co-authors, including Ng, Downey, Lupini, Turetsky, Nies, Koh, and Harrison-Trainor.

On the superstable part of the free group

Rizos Sklinos

Chinese Academy of Sciences

Abstract: The first-order theory of a nonabelian free group is stable but not superstable. Nevertheless, one can still seek to isolate the "superstable part" of its definable universe: namely, those definable sets whose Shelah rank is ordinal-valued. The aim of this talk is to discuss the main conjecture, according to which a first-order formula over a nonabelian free group is superstable precisely when its solution set does not change upon passing to any elementary extension which is again a free group.

In the first part of the talk, we will use tools from geometric stability theory, together with the definable simplicity of the free group, in the group-theoretic sense, to prove the necessity of the condition. The proof of sufficiency requires a deeper use of the machinery developed by Sela in his solution of the Tarski problem. I will introduce the relevant terminology and explain how certain definable sets are closely connected with the geometry of limit groups, that is, finitely generated models of the universal theory of a nonabelian free group. We will then relate this geometry to Shelah rank, thereby developing a practical method for computing Shelah ranks in free groups. The talk is based on joint work with Chloé Perin and Javier de la Nuez González.

	Beijing Time		Schedule	Location
Jun. 23	7:30-9:00		Breakfast	Hua Luogeng Lecture Hall
	AM	9:00-9:40	Gianluca Paolini, University of Turin Title: On the isomorphism problem for procountable groups and oligomorphic groups	
		9:40-10:00	Break	
		10:00-10:25	Ruiwen Li, Nankai University Title: Orbit Equivalence of Cantor Minimal Systems	
		10:25-10:40	Break	
		10:40-11:05	Tianhao Wang, Nankai University Title: Strong marker sets for arbitrary generating sets	
		11:05-11:20	Break	
		11:20-12:00	Andre Nies, University of Auckland Title: Turning non-Archimedean groups into countable structures	
	12:00-13:00		Lunch	
	PM	14:00-15:30	Collaboration Sessions	
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On the isomorphism problem for procountable groups and oligomorphic groups

Gianluca Paolini

University of Turin

Abstract: We present results from a cluster of papers on the Borel complexity of topological isomorphism for procountable and oligomorphic groups. On the procountable side, we present recent work, joint with Su Gao and André Nies, showing that topological isomorphism on 2-nilpotent procountable groups is not classifiable by countable structures.

On the oligomorphic side, we present results, partly joint with André Nies, showing that topological isomorphism is smooth on several natural subclasses of oligomorphic groups — in particular those with no algebraicity and those with weak elimination of imaginaries — while whether it is smooth on all oligomorphic groups remains an open question.

Orbit Equivalence of Cantor Minimal Systems

Ruiwen Li

Nankai University

Abstract: In this talk, we introduce the descriptive complexity of the topological orbit equivalence relation for some Borel classes of Cantor minimal systems. We focus on Cantor minimal systems with finitely many ergodic measures.

Within this class, the orbit equivalence on regular $\{0,1\}$-Toeplitz subshifts is Borel bireducible with $=^+$, whereas the orbit equivalence on topological rank finite Cantor systems is virtually countable. Moreover, the orbit equivalence on rank-2 systems is virtually amenable. In contrast, the orbit equivalence on rank-n systems is not virtually amenable when $n \geq 4$; the orbit equivalence on rank-n systems is not virtually treeable when $n \geq 5$. This work is joint with Su Gao and Yiming Sun.

Strong marker sets for arbitrary generating sets

Tianhao Wang

Nankai University

Abstract: We prove the existence of clopen strong marker sets in $F(2^{\mathbb{Z}^n})$ for arbitrary finite generating sets. Specifically, for any positive integers $n, d_0 \geq 1$ and any finite generating set $S \subseteq \mathbb{Z}^n$, we construct a clopen set $M \subseteq F(2^{\mathbb{Z}^n})$ and a positive integer Δ such that

(1) for any distinct $x, y \in M$ in the same orbit, $\rho(x, y) \geq d_0$;

(2) for any $v \in S$ and any $x \in F(2^{\mathbb{Z}^n})$, there are non-negative integers $a, b \leq \Delta$ such that $av \cdot x \in M$ and $-bv \cdot x \in M$.

As an application, we obtain a continuous proper edge $(2|S|+1)$-coloring of the Schreier graph on $F(2^{\mathbb{Z}^n})$ with generating set S, recovering a result of Gao–Wang–Wang.

Turning non-Archimedean groups into countable structures

Andre Nies

University of Auckland

Abstract: Non-Archimedean (nA) groups are the automorphism groups of structures, with the topology of pointwise convergence. Among Polish groups, these are the ones with a neighborhood basis of the identity consisting of open subgroups; in particular, they are totally disconnected.

The talk addresses questions related to descriptive set theory and computability theory for natural Borel classes of nA groups, such as the oligomorphic ones (where the structure can be chosen to be omega-categorical), and the locally compact ones (equivalently, the compact open subgroups form a neighborhood basis of the identity).

An important technical tool is a countable type of structure called meet groupoid, associated with each group in the class; its domain consists of the cosets of all open subgroups in a "natural" neighborhood basis, such as the compact ones in the locally compact case. Meet groupoids can for instance be used to show that the isomorphism relation on the class of oligomorphic groups is essentially countable (Schlicht and Tent, JML 2018), and to understand when a locally compact nA group is computable (with Melnikov, JSL 2026).

The outer automorphism group of an oligomorphic group is locally compact (with Paolini, BPAM 2026). This group can be understood as a group of self-bi-interpretations of the underlying structure (with Schlicht, Fund. Math. 2026). The latter paper also gives a Borel equivalence of categories between a Borel class of nA groups with topological isomorphism and their meet groupoids with isomorphism, whenever there is an isomorphism-invariant Borel assignment of the neighborhood basis of the identity to groups in the class. A computable version of this equivalence is open.

	Beijing Time		Schedule	Location
Jun. 24	7:30-9:00		Breakfast	Hua Luogeng Lecture Hall
	AM	9:00-9:40	Wei Wang, Sun Yat-Sen University Title: Iterated jumps of perfect subtrees of positive trees	
		9:40-10:00	Break	
		10:00-10:40	Daniel Max Hoffmann, University of Warsaw Title: Ergodic decomposition in NIP theories	
		10:40-10:50	Break	
		10:50-11:30	Takayuki Kihara, Nagoya University Title: Lawvere-Tierney topologies as combinatorial and computable complexity	
	12:00-13:00		Lunch	
	PM	14:00-17:30	Free Discussions	
	17:30-19:00		Dinner	

Iterated jumps of perfect subtrees of positive trees

Wei Wang

Sun Yat-Sen University

Abstract: A (binary) tree is *positive* iff its infinite paths form a set with positive Lebesgue measure. It is a well-known phenomenon in algorithmic randomness that positive trees contain infinite paths with weak computational power. By Cantor, positive trees always have perfect subtrees and even positive perfect subtrees. Chong et al. [1] studied computational power of perfect subtrees of positive trees, and to some extend showed that positive trees also contain perfect subtrees of weak computational power.

This work was followed up by Barmpalias and Wang [2], by Barmpalias and Zhang [3], and also by Greenberg, J. Miller and Nies [4]. This talk will survey the main results in the above works, and also sketch a recent result that every Δ_n positive tree contains a low_n perfect subtree.

References

[1] CHONG, CHITAT AND LI, WEI AND WANG, WEI AND YANG, YUE, *On the computability of perfect subsets of sets with positive measure*, ***Proceedings of the American Mathematical Society***, vol. 147 (2019), no. 9, pp. 4021–4028.

[2] BARMPALIAS, GEORGE AND WANG, WEI, *Pathwise-randomness and models of second-order arithmetic*, ***Information and Computation***, vol. 299 (2024), 105181.

[3] BARMPALIAS, GEORGE AND ZHANG, XIAOYAN, *Growth and irreducibility in path-incompressible trees*, ***Information and Computation***, vol. 297 (2024), 105136.

[4] GREENBERG, NOAM AND MILLER, JOSEPH S. AND NIES, ANDRÉ, *Highness properties close to PA completeness*, ***Israel Journal of Mathematics***, vol. 244 (2021), pp. 419–465.

Ergodic decomposition in NIP theories

Daniel Max Hoffmann
University of Warsaw

Abstract: I will discuss an ergodic decomposition theorem for invariant Keisler measures in amenable NIP theories, based on joint work with Tomasz Rzepecki. The starting point is the natural action of the automorphism group of a monster model on spaces of types and Keisler measures. Using the *-product on invariant types and measures introduced in joint work with Gannon and Krupiński, one obtains a semigroup structure on the space of invariant types; in the amenable NIP context, the f-generic types form its unique minimal left ideal, and the relevant Ellis groups are controlled by the Kim–Pillay Galois group.

The main result identifies the ergodic invariant Keisler measures with measures obtained from normalized Haar measure on Kim-Pillay group, measured along Ellis groups of the minimal ideal of f-generic types. I will also explain how this picture suggests a broader programme: Generalized Newelski Conjecture and Bohr compactifications should provide analogous Haar-pullback mechanisms for more general model-theoretic flows.

D.M. Hoffmann, T. Rzepecki, On idempotent measure conjecture and decomposition of invariant measures, arXiv:2511.22945.

Lawvere-Tierney topologies as combinatorial and computable complexity

Takayuki Kihara

Nagoya University

Abstract: The speaker provides an overview of recent developments regarding Lawvere-Tierney topologies/sheaf subtoposes of the effective topos and its relatives. The structure of these sheaf subtoposes is related, set-theoretically, to the Rudin-Keisler/Katetov order, and computability-theoretically, to the Weihrauch degrees. When the base topos is the Grayson topos, the corresponding structure is also related to the total Weihrauch degrees. The speaker presents some applications to constructive mathematics.

	Beijing Time		Schedule	Location
Jun. 25	7:30-9:00		Breakfast	Hua Luogeng Lecture Hall
	AM	9:00-9:40	Jialiang He, Sichuan University Title: Definability of Maximal Eventually Different Families over Ideals	
		9:40-10:00	Break	
		10:00-10:25	Guozhen Shen, Sun Yat-Sen University Title: Accounts of Set Size and the Axiom of Choice	
		10:25-10:40	Break	
		10:40-11:05	Philipp Schlicht, University of Siena Title: The Wadge hierarchy for generalized Cantor spaces	
		11:05-11:20	Break	
		11:20-12:00	Noam Greenberg, Victoria University of Wellington Title: Borel graph colourings and untagging	
	12:00-13:00		Lunch	
	PM	14:00-15:30	Collaboration Sessions	
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		16:00-17:30	Problem Session Chair: Su Gao	
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Definability of Maximal Eventually Different Families over Ideals

Jialiang He

Sichuan University

Abstract: This talk presents a series of results, from joint work, on extending definable maximal eventually different families to ideals. A family $E \subseteq \mathbb{N}^{\mathbb{N}}$ is maximal eventually different (med) if it is maximal among families whose members pairwise agree on only finitely many coordinates. While many maximal structures cannot be analytic, Horowitz–Shelah and Schrittesser showed there is a closed med family.

The work generalizes this to ideals: for an ideal I, an I-med family relaxes "finitely many" to "in I". Isolating a uniform weak Ramsey property of subadditive colorings yields closed I-med families for every F_σ ideal. Building on this, closed I-med families are shown to exist for several further classes of ideals, including Σ^0_3 ideals, the ideals $I(A)$ generated by a Borel almost disjoint family A, and the iterated Fréchet ideals Fin^α. In contrast, for every Ramsey ultrafilter U and countable ordinal α there is no analytic $(U^\alpha)^*$-med family. Together these results mark a sharp boundary for the definability of I-med families.

Accounts of Set Size and the Axiom of Choice

Guozhen Shen

Sun Yat-Sen University

Abstract: We compare two accounts of set size in set theory without the axiom of choice: the first based on injections and the second on surjections. We then propose a new account of set size that has better properties than the previous two in choice-free settings.

The Wadge hierarchy for generalized Cantor spaces

Philipp Schlicht

University of Siena

Abstract: The structure of the Wadge hierarchy for the Cantor space 2^ω is well understood assuming the axiom of determinacy. We study the Wadge hierarchy for generalized Cantor spaces 2^κ for uncountable cardinals κ with $2^{<\kappa} = \kappa$.

In the regular case, the structure within the difference hierarchy over closed sets resembles the one for the Cantor space, in particular it satisfies the semi-linear ordering principle and is wellfounded. However, these structural features already break down below the second level of the κ-Borel hierarchy. We pursue a detailed analysis of sets in the difference hierarchy and immediately beyond. This is joint work with Beatrice Pitton and Luca Motto Ros.

Borel graph colourings and untagging

Noam Greenberg

Victoria University of Wellington

Abstract: In light of the G_0-dichotomy (Kechris-Solecki-todocevic), Lecomte and Zeleny asked for least graphs with no Σ^0_α-measurable countable colourings; the provided examples for $\alpha = 1, 2, 3$.

We describe classes of graphs with no Σ^0_α colourings, using notions of forcing inspired by Steel's tagged tree forcing. These notions of forcing are also useful in calculating the Borel rank of some classes from computability theory (namely, the high_α sets), and for a new proof of a non-separation result for the iterated Fréchet ideals and filters, due to Debs and Saint Raymond. This is largely joint work with Lecomte, Turetsky, and Zeleny.

	Beijing Time		Schedule	Location
Jun. 26	7:30-9:00		Breakfast	Hua Luogeng Lecture Hall
	AM	9:00-9:40	Ted Slaman, University of California Berkeley Title: Hausdorff Dimension and the Borel Hierarchy	
		9:40-10:00	Break	
		10:00-10:40	Goh Jun Le, National University of Singapore Title: Accounts of Set Size and the Axiom of Choice	
		10:40-10:50	Break	
		10:50-11:30	Ningyuan Yao, Fudan University Title: Newelski's Conjecture for o-Minimal and p-Adic Definable Groups	
	12:00-13:00		Lunch	
	PM	14:00-17:30	Free Discussions	
	17:30-19:00		Dinner	

Hausdorff Dimension and the Borel Hierarchy

Ted Slaman

University of California Berkeley

Abstract: The gauge profile of a subset of $\mathbb{R}^n$ is the set of gauge functions whose associated gauge measures assign the set positive measure. We will discuss the open question of whether new gauge profiles appear cofinally in the Borel hierarchy. We will show that for every countable α there is a countable β and a Σ^0_β set A such that no Σ^0_α subset of A has the same gauge profile as A does. This is joint work with Leo Harrington.

A recursion-theoretic analogue of Morley's categoricity theorem

Goh Jun Le

National University of Singapore

Abstract: Morley's categoricity theorem says that if a countable first-order theory is categorical in one uncountable cardinal, then it is categorical in every uncountable cardinal. We report on joint work with Tran Chieu-Minh where we formulate and prove a recursion-theoretic analogue of Morley's theorem, replacing cardinality with arithmetic degree, the degree of complexity under arithmetical reducibility. Our proof adapts the Baldwin–Lachlan strategy to this setting. As part of this, we introduce a notion of arithmetic stability analogous to ω-stability. This gives a new recursion-theoretic perspective on a central structural phenomenon in model theory: uniqueness at one level of complexity forces internal structure.

Newelski's Conjecture for o-Minimal and p-Adic Definable Groups

Ningyuan Yao

Fudan University

Abstract: Let M_0 be either the p-adic field $\mathbb{Q}_p$ or an o-minimal expansion of the real field $\mathbb{R}$. We study minimal flows and Ellis groups of definable groups over M_0 within the framework of definable topological dynamics.

Fix a definable group G over M_0, and let B denote its definably amenable component. We interpret B as the maximal definably amenable subgroup of G. Our central theorem establishes that for any elementary extension $M \succ M_0$, the Ellis group of the universal definable flow of G over M is isomorphic to that of B over M. Consequently, the Ellis group of the universal definable flow of G is model-independent, matching the invariance property satisfied by B. As a key corollary, we obtain an equivalence for the p-adic case: Newelski's Conjecture holds for G over $\mathbb{Q}_p$ if and only if G is definably amenable.