THE BULLETIN OF SYMBOLIC LOGIC
Volume 19, Number 2, June 2013

2012 NORTH AMERICAN ANNUAL MEETING OF THE ASSOCIATION FOR SYMBOLIC LOGIC

University of Wisconsin
Madison, WI, USA
March 31–April 3, 2012

The 2012 North American Annual Meeting of the Association was held on the campus of the University of Wisconsin at Madison, March 31–April 3, 2012. The program included the Gödel lecture, nine one-hour invited plenary talks, five special sessions, and four sessions of contributed talks. A reception was held on Saturday evening.

The members of the Program Committee were Jeremy Avigad, Bradd Hart (Chair), Arnold Miller, Gopalan Nadathur, and Jan Reimann. The members of the Local Organizing Committee were Uri Andrews, Mingzhong Cai, Steffen Lempp (Chair), Arnold Miller, and Joseph Miller.

There were 111 registered participants at the meeting, including 45 graduate students. Generous financial support was provided by the Department of Mathematics of the University of Wisconsin, the logic group at Wisconsin, the National Science Foundation, and the Association for Symbolic Logic.

John Steel delivered the Gödel lecture on *The hereditarily ordinal definable sets in models of determinacy*. The plenary addresses at the meeting were:

Alan Dow (UNC Charlotte), *Compact spaces, converging sequences and set theory*.
Isaac Goldbring (UCLA), *Definability in metric structures*.
Warren Goldfarb (Harvard), *Wittgenstein against logicism*.
Joseph Miller (Wisconsin), *Lebesgue density and cupping with K-trivial sets*.
Toniann Pitassi (Toronto), *Differential privacy and fairness in classification*.
Antonio Montalbán (Chicago), *Computability of quasi-well-orderings*.
Grigor Sargsyan (Rutgers), *The Solovay hierarchy*.
Sergei Starchenko (Notre Dame), *On Peterzil-Steinhorn groups definable in algebraically closed fields*.
Moshe Vardi (Rice), *From philosophical to industrial logics*.

There were five special sessions (with organizers in parentheses): Computability (Laurent Bienvenu and Jan Reimann), History of logic on the centenary of the birth of Jean van Heijenoort (Thomas Drucker), Model theory (Bradd Hart and Michael C. Laskowski), Set theory (Dilip Raghavan and Juris Steprāns), and Structural proof theory (Dale Miller). There were a total of twenty nine speakers.

Abstracts of the invited talks and the contributed talks (given in person or by title) by members of the Association for Symbolic Logic follow.

For the Program Committee
BRADD HART

1079-8986/13/1902-0005/$3.10
DOI:10.2178/bsl.1902050

Abstract of the invited 23rd Annual Gödel Lecture

► JOHN STEEL, *The hereditarily ordinal definable sets in models of determinacy*.
Department of Mathematics, The University of California, 717 Evans Hall # 3840, Berkeley, CA 94720-3840, USA.
E-mail: steel@math.berkeley.edu.

If M is a model of the Axiom of Determinacy, then universe $\mathrm{HOD}^{\mathrm{M}}$ of all sets hereditarily ordinal definable in M is of great interest. $\mathrm{HOD}^{\mathrm{M}}$ is a model of ZFC plus "there are Woodin cardinals" which, roughly speaking, has the same information as M.

If the determinacy model M is not too large, then its HOD admits a fine-structural analysis parallel to fine-structural analysis of canonical extender models with large cardinals. (For example, HOD satisfies the GCH.) There are, however, some important new features. How to extend the fine-structural analysis of HOD to larger determinacy models is one of the central open problems in pure large cardinal theory.

In this lecture, we shall give an overview of the fine structure of $\mathrm{HOD}^{\mathrm{M}}$ in the region where we know it, and try to explain why it is important to extend this region further.

Abstracts of invited plenary talks

► ALAN DOW, *Compact spaces, converging sequences, and set-theory*.
Department of Mathematics and Statistics, University of North Carolina at Charlotte, 9201 University City Boulevard, Charlotte, NC 28223, USA.
E-mail: adow@uncc.edu.

In the field of set-theoretic topology, fundamental questions that can be thought of as asking for a sufficient supply, or even the existence, of converging sequences in compact spaces have been shown to be highly set-theoretic and frequently undecidable. Early work by Sapirovskiĭ uncovered an important connection to special ω_1-sequences called free sequences. More recent work by several authors went further and showed the relevance of converging ω_1-sequences (in the co-countable sense of convergence). A space is said to be sequential if the closure of a set can always be obtained by iteratively adding limits of converging sequences. A landmark result in this study is the independence of the Moore–Mrowka question which can now be formulated as asking if every compact space with no uncountable converging free ω_1-sequences is sequential. The proper forcing axiom (PFA) decides this in the affirmative, $\diamondsuit$ decides in the negative, and it is unknown if CH or Martin's Axiom decides it. We review the methods and the present state of several open problems of a similar nature. We are also looking at a new problem of this type: if a compact space contains no converging ω_1-sequences, must it contain a point which is a G_δ?

► ISAAC GOLDBRING, *Definability in metric structures*.
Department of Mathematics, University of California at Los Angeles, Box 951555, Los Angeles, CA 90095-1555, USA.
E-mail: isaac@math.ucla.edu.

Continuous logic is a relatively new logic better equipped for studying the model theory of structures based on complete metric spaces. There are continuous analogs of virtually every notion and theorem from classical model theory, often with equalities replaced by approximations. However, most of the work done in continuous logic has centered around sophisticated topics concerning stability and its generalizations. In this talk, I will discuss the more basic notion of definability in metric structures. More specifically, I will consider the question of which functions are definable in some metric structures. I will present concrete descriptions of the class of functions that are definable in Urysohn's metric space as well as which linear operators are definable in infinite-dimensional Hilbert spaces. If time permits, I will discuss the functions definable in some other metric structures as well as definable functions in pseudofinite metric structures. I will not assume that the audience has been exposed to continuous logic and will begin my talk by introducing the subject.

► WARREN GOLDFARB, *Wittgenstein against logicism*.
Department of Philosophy, Harvard University, Cambridge, MA 02138, USA.
E-mail: goldfarb@fas.harvard.edu.

In his *Tractatus Logico-Philosophicus*, published in 1921, Wittgenstein rejected the Frege–Russell construction of number, and indeed the whole idea of a logicist or set-theoretic reduction of arithmetic. The paper canvasses the grounds for his critical stance, and surveys what he sought to put in its place. This includes his proposal of a linguistically-based infinitary logic, whose strength is investigated. A reconstruction of his reasons for construing logic in this way reveals unlikely parallels with the anti-logicist criticisms of Henri Poincaré, as well as links to Wittgenstein's openly anti-foundational philosophy of mathematics of his later period.

► JOSEPH S. MILLER, *Lebesgue density and cupping with K-trivial sets*.
Department of Mathematics, University of Wisconsin, 480 Lincoln Drive, Madison, WI 53706-1388, USA.
E-mail: jmiller@math.wisc.edu.

Many theorems in analysis translate global niceness assumptions into good local behavior at almost every real number. Such theorems can provide an interesting link between computable analysis and effective randomness. For example, a function of bounded variation is differentiable at almost every real. Demuth [1975] proved that computable functions of bounded variation are differentiable at the Martin-Löf random reals, and in fact, that this is a characterization of Martin-Löf randomness. We consider a similar treatment of the Lebesgue density theorem.

If $C \subseteq \mathbb{R}$ is measurable, define the (lower) density of $x \in \mathbb{R}$ to be $\rho(x \mid C) = \liminf_{a,b \to 0^+} \mu(C \cap [x-a, x+b])/(a+b)$. The Lebesgue density theorem states that $\rho(x \mid C) = 1$ for almost all $x \in C$. Bienvenu, Hölzl, Nies and I studied the reals x that satisfy this theorem for every Π^0_1 class (i.e., effectively closed set) containing x. One of the main results so far is that if x is Martin-Löf random, then $\rho(x \mid C) > 0$ for every Π^0_1-class containing x iff x does not compute the halting problem. This result is particularly interesting because Adam Day and I were able to use it to solve an open problem about the K-trivial sets.

The K-trivial sets have been the subject of a great deal of work in effective randomness and many characterizations are known. For example, they are exactly the sets that cannot help derandomize any Martin-Löf random real [Nies 2005]. Antonin Kučera asked if the K-trivial sets could be characterized as those that cannot be cupped above $\emptyset'$ with an incomplete Martin-Löf random (i.e., a random that does not itself compute the halting problem). Furthermore, under the assumption that the non-K-trivial set is Δ^0_2, he asked if the incomplete Martin-Löf random cupping partner could also be Δ^0_2. Adam Day and I answered both questions in the affirmative, using the Lebesgue density result to show that if A is K-trivial, X is Martin-Löf random, and $A \oplus X$ computes $\emptyset'$, then X computes $\emptyset'$.

► ANTONIO MONTALBAN, *The computability of well-quasi-orderings*.
Department of Mathematics, University of Chicago, 5734 S. University Avenue, Chicago, IL 60637, USA.
E-mail: antonio@math.uchicago.edu.

We discuss some recent and some older work on the computability of well-quasi-orderings (wqo). In particular we will talk about recent work joint with Alberto Marcone and Richard

A. Shore on the problem of finding maximal chains in a wqo. A classical theorem says that maximal chains always exists in wqos, but we will prove that this result does not hold computably. More interestingly, we show that if an oracle is generic enough, it can compute such maximal chains.

► TONIANN PITASSI, *Differential privacy and fairness in classification*.
Department of Computer Science, University of Toronto, Sandford Fleming Building, 10 King's College Road, Room 2305A, Toronto, Ontario, M5S 3G4, Canada.
E-mail: `toni@cs.toronto.edu`.

In this talk, we will discuss two recent and interconnected frameworks for privacy and fairness in classification. The problem of statistical disclosure control—revealing accurate statistics about a population while preserving privacy of individuals—has a rich history. Differential privacy is a new concept developed within the last ten years and ensures that the system behaves essentially the same way, independent of whether any individual opts in to or opts out of the database. A related objective is fairness in classification. The goal here is to classify individuals while both preventing discrimination and maintaining utility for the classifier.

In this talk, we will survey the main notions and advances in differential privacy, and then present a new framework for fair classification, and its connection to differential privacy.

This is joint work with Cynthia Dwork, Moritz Hardt, Omer Reingold and Richard Zemel.

► GRIGOR SARGSYAN, *The Solovay hierarchy*.
Department of Mathematics, Rutgers University, Hill Center for the Mathematical Sciences, 110 Frelinghuysen Road, Piscataway, NJ 08854-8019, USA.
E-mail: `grigor.rutgers@gmail.com`.

It is a well-known and a fascinating phenomenon that the large cardinal hierarchy forms a consistency strength hierarchy, i.e., large cardinal axioms form a linear hierarchy ordered by their consistency strengths and, which is what makes it all very fascinating, the consistency of almost any known interesting mathematical theory can be reduced to the consistency of a large cardinal axiom. Lets call this the large cardinal phenomenon. In order to argue that large cardinal hierarchy can indeed be taken to be the backbone of all of mathematics, one at least needs to reverse the above consistency reductions and show that the consistency of many natural and interesting mathematical theories entail the consistency of large cardinal axioms. However, such reversals have only been worked out for a very small initial segment of large cardinal hierarchy. Recently the Solovay hierarchy, which is a descriptive set theoretic hierarchy, has been used by several authors to establish such reversals by using the Solovay hierarchy as an intermediary. These new methods have been used to formulate a general program for establishing such reversals at every level of the consistency strength hierarchy. In this talk, we will outline the evidence that supports the large cardinal phenomenon and also outline the new program mentioned above. Some recent results will be stated and hopefully, some proofs will be given.

► SERGEI STARCHENKO, *On Peterzil–Steinhorn groups definable in algebraically closed fields*.
Department of Mathematics, University of Notre Dame, Notre Dame, IN 46556, USA.
E-mail: `sstarche@nd.edu`.

In the paper "Definable compactness and definable subgroups of o-minimal groups" Y. Peterzil and C. Steinhorn showed that for any unbounded curve in a group definable in an o-minimal structure one can associate a definable one-dimentional subgroup.

Very roughly it is a subgroup that is "tangent at infinity" to the curve. In this talk we show that the same can be done for algebraic groups over arbitrary algebraically closed field.

This is a joint work with Moshe Kamensky.

► MOSHE VARDI, *From philosophical to industrial logics*.
Department of Computer Science, Mail Stop 132, Rice University, 6100 S. Main Street, Houston, TX 77005-1892, USA.
E-mail: vardi@cs.rice.edu.

One of the surprising developments in the area of program verification is how several ideas introduced by logicians in the first part of the 20th century ended up yielding at the start of the 21st century industry-standard property-specification languages called PSL and SVA. This development was enabled by the equally unlikely transformation of the mathematical machinery of automata on infinite words, introduced in the early 1960s for second-order arithmetics, into effective algorithms for industrial model-checking tools. This talk attempts to trace the tangled threads of this development.

Abstracts of invited talks in the Special Session on Computability

► CHRIS CONIDIS, *Proving that Artinian implies Noetherian without proving that Artinian implies finite length*.
Department of Mathematics, 200 University Avenue West, University of Waterloo, Waterloo, ON N2L 3G1, Canada.
E-mail: cconidis@math.uwaterloo.ca.

Let R be a commutative ring with identity. Recall from basic graduate algebra that:

1. R is Noetherian if it satisfies the ascending chain condition on its ideals;
2. R is Artinian if it satisfies the descending chain condition on its ideals; and
3. R is of finite length if there is a uniform bound on the length of any (strictly increasing/decreasing) chain of ideals in R.

It is well-known that 2 implies 1, but the proofs given in most standard algebra texts prove this by showing the stronger statement that 2 implies 3. This begs the question: "Can one prove that 2 implies 1 without showing that 2 implies 3?" We will show that this is indeed the case by showing that, in the context of reverse mathematics, the former (weaker) statement is equivalent to weak König's lemma, while the latter (stronger) statement is equivalent to arithmetic comprehension in the context of ω-models. Another way to view our main result is that it constructs an ω-model of RCA (recursive comprehension axiom) in which 2 implies 1, but 2 does not imply 3.

► ADAM DAY, *A random Turing degree*.
Department of Mathematics, 970 Evans Hall, University of California, Berkeley, CA 94720-3840, USA.
E-mail: adam.day@math.berkeley.edu.

The theory of algorithmic randomness provides a means of defining when a subset of the natural numbers is random. This definition can be carried over to the Turing degrees by defining a Turing degree as random if it contains a random set. In this talk we will examine the properties of a random Turing degree, focusing on those Turing degrees that contain a 2-random set.

One surprising fact is that a number of properties of such a degree are shared by all non-zero degrees below it. We will outline why every non-computable set below a 2-random set computes a 1-generic (an extension of a result by Kurtz). We will explain why similar techniques can be used to prove that all degrees below a 2-random degree have the join property and related results.

This is joint work with George Barmpalias and Andy Lewis.

► DAMIR D. DZHAFAROV, *Computable Mathias genericity*.
Department of Mathematics, University of Notre Dame, 255 Hurley Hall, Notre Dame, IN 46556, USA.
E-mail: ddzhafar@nd.edu.

Mathias forcing, originally formulated in set theory, has found a number of important applications in computability theory and reverse mathematics. I will discuss some recent joint work with Peter A. Cholak and Jeffry L. Hirst studying the Turing degrees of generics for computable Mathias forcing, and how they relate to those of Cohen generics.

► RACHEL EPSTEIN, *Prompt sets and automorphisms of* $\mathcal{E}$.
Department of Mathematics, Harvard University, 1 Oxford Street, Cambridge, MA 02138, USA.
E-mail: repstein@math.harvard.edu.

The computably enumerable (c.e.) sets form a lattice $\mathcal{E}$ under set inclusion. We can use this structure to examine which degree-theoretic properties of sets (such as lowness) are definable in the language of set theory. For example, Harrington and Soare, and independently, Cholak, have shown that any non-computable set can be taken by an automorphism of $\mathcal{E}$ to a high set. This tells us that, for instance, the low sets and the nonhigh sets are not definable classes. Cholak, Downey, and Stob showed that any promptly simple set is effectively automorphic to a complete set, and Harrington and Soare showed that any prompt set (one of promptly simple degree) is Δ^0_3-automorphic to a complete set. The techniques they develeoped demonstrate how the promptness of A allows us to code information into a set automorphic to A.

A set S is *semilow* if $\{e\colon W_e \cap S \neq \emptyset\} \leq_{\mathrm{T}} \mathbf{0}'$. If $\overline{A}$ is semilow, we can restrain information from entering a set automorphic to A. For example, $\overline{A}$ semilow implies that A is effectively automorphic to a low set, as Soare has shown. Wald showed that $\overline{A}$ semilow implies that A is Δ^0_3-automorphic to a set B below any promptly simple set C. Can we guarantee that B is of the same degree as C if we add the hypothesis that A is prompt, in order to code C into B? If so, then we will know that every prompt set with semilow complement, including every prompt low set, is automorphic to a set of every prompt degree. One interesting property of this problem is that the usual Δ^0_3-automorphism machinery is unable to handle the situation of both coding and permitting (to keep $B \leq_{\mathrm{T}} C$). We thus turn to effective automorphisms and the original Extension Theorem of Soare.

► PETER GERDES, *Orbits of D-maximal sets in* $\mathcal{E}$.
Department of Mathematics, University of Notre Dame, 255 Hurley Hall, Notre Dame, IN 46556, USA.
E-mail: gerdes@invariant.org.

Automorphisms of the $\mathcal{E}$, the c.e. sets under containment, have long been an object of significant interest in computability theory. As the orbit of a set in $\mathcal{E}$ is closely related to it's algebra of supersets studying the orbits of sets with particularly simple lattices of supersets (large sets) has proved to be a fruitful means of investigation. While the orbits of maximal, hemimaximal, r-maximal and hyperhypersimple sets have been well studied less is known about the orbits of $\mathcal{D}$-maximal sets. The notion of a $\mathcal{D}$-maximal set generalizes that of a maximal set by requiring that the set only look maximal modulo disjoint c.e. sets. As it is known that there is a single orbit of $\mathcal{E}$ containing the maximal sets and a single orbit containing the hemimaximal sets but both the r-maximal and hyperhypersimple sets break into ω many distinct orbits it's unclear how many orbits we should expect for the $\mathcal{D}$-maximal sets. Previous work by Cholak has shown that a certain well-behaved class of $\mathcal{D}$-maximal sets form a single orbit. In joint work with Karen Lange and Peter Cholak we modify a technique used by Nies and Cholak on atomless r-maximal sets to show that in contrast to the earlier partial result the $\mathcal{D}$-maximal sets belong to infinitely many distinct orbits. After giving a overview of this result I will consider applications to degree theoretic properties of the automorphisms and extensions to other flavors of $\mathcal{D}$-maximal sets than those used in our proof and the $\mathcal{D}$-hyperhypersimple sets.

► ANDREW MARKS, *Global problems in recursion theory and weakly universal countable Borel equivalence relations*.
Department of Mathematics, 970 Evans Hall, University of California, Berkeley, CA 94720-3840, USA.
E-mail: asmarks@math.berkeley.edu.

The global properties of degree structures from recursion theory have been actively studied for many years. Recent trends in descriptive set theory have offered a new perspective into this topic, and interesting connections have been discovered between recursion theory, countable Borel equivalence relations, and Borel combinatorics. We will present an overview of these connections, concentrating particularly on Turing reducibility, recursive isomorphism, and the structure of the weakly universal countable Borel equivalence relations.

► PAUL SHAFER, *Presenting the effectively closed Medvedev degrees requires* $\mathbf{0}'''$.
Department of Mathematical Sciences, Appalachian State University, 121 Bodenheimer Drive, Walker Hall, Boone, NC 28608, USA.
E-mail: shaferpe@appstate.edu.
URL Address: http://www.appstate.edu/~shaferpe/.

We continue the project of characterizing the complexities of the Medvedev degrees, Muchnik degrees, and their substructures by proving that a Turing degree computes a presentation of the effectively closed Medvedev degrees if and only if that Turing degree computes $\mathbf{0}'''$. In the language of computable structure theory, this result asserts that the degree spectrum of the effectively closed Medvedev degrees is the cone above $\mathbf{0}'''$.

Abstracts of invited talks in the Special Session on Model Theory

► MARTIN BAYS, *Abelian functions and categoricity*.
Department of Mathematics & Statistics, McMaster University, 1280 Main Street West, Hamilton, Ontario, L8S 4K1, Canada.
E-mail: mbays@math.mcmaster.ca.

An elliptic function is a meromorphic function which is simultaneously periodic in two directions on the complex plane, and abelian functions are their higher-dimensional analogues. They are precisely the meromorphic functions which factor via abelian varieties, and so are tightly connected to algebraic geometry. Correspondingly, the model theory of appropriate structures defining abelian functions, though complicated by the periodicity, is relatively tame. Following Zilber and Gavrilovich, I will discuss some such structures with an emphasis on categoricity and classification theoretic concerns.

► VINCENT GUINGONA, *On VC-minimal theories*.
Department of Mathematics, University of Notre Dame, 255 Hurley, Notre Dame, IN 46556, USA.
E-mail: guingona.1@nd.edu.

In this talk, we discuss recent developments on VC-minimal theories. We talk about convex orderability and use this to give some examples of theories that are dp-minimal but not VC-minimal. We also give a means of canonically decomposing formulas in VC-minimal theories. Finally, we use this to compute the VC-density of formulas in VC-minimal theories.

Some of this work is joint with Joseph Flenner.

► MOSHE KAMENSKY, *Internal covers of categories*.
Department of Mathematics, University of Notre Dame, Notre Dame, IN 46556, USA.
E-mail: kamensky.1@nd.edu.

I will explain how the model theoretic notion of internality, and the resulting Galois group, can be formulated in terms of the categorical structure of the categories of definable sets in the theories involved.

This talk was not given; it was presented by title.

► ALEXEI KOLESNIKOV, *Homology groups in model theory*.
Towson University, 8000 York Road, Towson, MD 21252, USA.
E-mail: AKolesnikov@towson.edu.

This talk will introduce definitions of homology groups associated with a family of generalized amalgamation problems. We then describe the basics of homology theory in the model-theoretic context of stable first-order theories and connect the homology group with the automorphism group of a certain *abelian closure* (part of the algebraic closure of a finite sequence of independent elements in a model). We show that if the generalized amalgamation properties hold, then the homology groups are trivial. We also prove that second homology groups for strong types in stable theories must be profinite abelian.

► KOUSHIK PAL, *Model companion of unstable theories with an automorphism*.
Department of Mathematics, 4117 Mathematics Building, University of Maryland, College Park, MD 20740, USA.
E-mail: koushik@umd.edu.

Let T be a theory in a first-order language $\mathcal{L}$. Let $\mathcal{L}_\sigma := \mathcal{L} \cup \{\sigma\}$ be the old language $\mathcal{L}$ together with a new unary function symbol σ, and let $T_\sigma := T \cup \{$“σ is an $\mathcal{L}-$automorphism”$\}$. Kikyo and Shelah showed that if T has the strict order property (SOP), then T_σ does not have a model companion in $\mathcal{L}_\sigma$. However, if we put more restrictions on σ, then it turns out that T_σ, with the restricted class of automorphisms, can have a model companion in $\mathcal{L}_\sigma$, even for a theory T with the SOP. I will give a few such examples in this talk.

► LYNN SCOW, *Ramsey classes of finite trees*.
Mathematics, Statistics, and Computer Science, University of Illinois at Chicago, M/C 249, 851 S. Morgan Street, 322 Science and Engineering, Chicago, IL 60607-7045, USA.
E-mail: lynn@math.uic.edu.

Various tree-indexed indiscernibles have been used in model theoretic contexts in the past few years, for example in [1], [3]. A tree-indexed indiscernible is a sequence of tuples of parameters $(a_\eta : \eta \in S)$ from a model M indexed by a tree S. We understand S as a structure in its own right in some language L' expanding the partial tree-order $\{\trianglelefteq\}$. The indiscernible must satisfy the condition that finite tuples from S with the same quantifier-free L'-type index tuples $\overline{a}_{\overline{\eta}}$ with the same complete type in M.

Often a partition property for trees yields a result about tree-indexed indiscernibles. The translation from partition property to index language L' is not always obvious, and the characterization of Ramsey classes in [2] offers an interesting clarification.

We will survey some Ramsey-type results on classes of finite trees and look at new ways known tree-indexed indiscernibles can inform our knowledge of Ramsey classes.

[1] M. DŽAMONJA AND S. SHELAH, *On $\triangleleft^*$-maximality*, ***Annals of Pure and Applied Logic***, vol. 125 (2004), no. 1–3, pp. 119–158.

[2] A. S. KECHRIS, V. G. PESTOV, AND S. TODORCEVIC, *Fräissé limits, Ramsey theory, and topological dynamics of automorphism groups*, ***Geometric and Functional Analysis***, vol. 15 (2005) no. 1, pp. 106–189.

[3] B. KIM AND H.-J. KIM, *Notions around tree property 1*, ***Annals of Pure and Applied Logic***, vol. 162 (2011), no. 9, pp. 698–709.

Abstracts of invited talks in the Special Session on Set Theory

► CLINTON CONLEY, *Independence numbers of graphs and group actions*.
Department of Mathematics, Cornell University, 310 Mallot Hall, Ithaca, NY 14853-4201, USA.
E-mail: clintonc@math.cornell.edu.

Given a graph on a standard probability space, a set is *independent* if no two points are adjacent; the *independence number* is then the supremum of measures of independent Borel sets. We present some recent results concerning these independence numbers, focusing on graphs induced by measure-preserving actions of countable groups.

This is joint work with A. S. Kechris and R. D. Tucker-Drob.

► VERA FISCHER, *Mad families, splitting families and large continuum*.
Kurt Gödel Research Center, University of Vienna, Währinger Strasse 25, 1090 Vienna, Austria.
E-mail: vera.fischer@univie.ac.at.

Let $\kappa < \lambda$ be regular uncountable cardinals. Using finite support iteration of ccc posets we obtain the consistency of $\mathfrak{b} = \mathfrak{a} = \kappa < \mathfrak{s} = \lambda$. If μ is a measurable cardinal and $\mu < \kappa < \lambda$, then using similar techniques we obtain the consistency of $\mathfrak{b} = \kappa < \mathfrak{a} = \mathfrak{s} = \lambda$.

► CARLOS MARTINEZ-RANERO, *Well quasi-ordering Aronszajn lines*.
Centro de Ciencias Matematicas, UNAM, Mailing Address: Antigua Carretera a Pátzcuaro # 8701, Col. Ex-Hacienda de San José de la Huerta, C.P. 58190, Morelia, Michoacán, México.
E-mail: azarel@math.toronto.edu.

We shall show that assuming the Proper Forcing Axiom, the class of Aronszajn lines are well quasi-ordered by the embeddability relation. Moreover, every Aronszajn line admit a decomposition analogous to Cantor's normal form.

► ANDREA MEDINI AND DAVID MILOVICH, *The topology of ultrafilters as subspaces of 2^ω*.
Department of Mathematics, University of Wisconsin – Madison, 480 Lincoln Drive, Madison, WI 53706, USA.
E-mail: medini@math.wisc.edu.
Department of Engineering, Mathematics, and Physics, Texas A&M International University, 5201 University Boulevard, Laredo, TX 78041, USA.
E-mail: david.milovich@tamiu.edu.

By identifying subsets of ω with elements of 2^ω through characteristic functions, it is possible to study the topological properties of any $\mathcal{X} \subseteq \mathcal{P}(\omega)$. We will focus on the case $\mathcal{X} = \mathcal{U}$, where $\mathcal{U}$ is a non-principal ultrafilter on ω. In particular, we will investigate countable dense homogeneity, the perfect set property, the property of being completely Baire, and their relation with the combinatorial property of being a P-point. Most of the results are obtained under Martin's Axiom for countable posets.

[1] A. MEDINI AND D. MILOVICH, *The topology of ultrafilters as subspaces of 2^ω*, ***Topology and its Applications***, vol. 159 (2012), no. 5, pp. 1318–1333.

► ASSAF RINOT, *The extent of the failure of Ramsey's theorem at successor cardinals*.
The Fields Institute for Research in Mathematical Sciences, 222 College Street, Toronto, Ontario, M5T 3J1, Canada.
E-mail: assaf@rinot.com.
URL Address: http://www.assafrinot.com.

Ramsey's theorem asserts that for every function $f\colon [\omega]^2 \to 2$, there exists an infinite subset $H \subseteq \omega$ such that $f \restriction [H]^2$ is constant. At the early 1930's, Sierpiński showed that a generalization of Ramsey's theorem must fail for successor cardinals, and ever since the extent of this failure was studied extensively by many set-theorists, including, Erdös, Eisworth, Hajnal, Moore, Shelah, and Todorčević.

In this talk, we shall show that Shelah's strongest notion of coloring $\mathrm{Pr}_0(\lambda^+, \lambda^+, \lambda^+, \omega)$ coincides with the most basic concept considered already by Erdös and his collaborators: $\lambda^+ \not\to [\lambda^+]^2_{\lambda^+}$. More specifically, we shall discuss the following ZFC result.

THEOREM 1. *The following are equivalent for every uncountable cardinal* λ:

1. *There exists a coloring* $c : [\lambda^+]^2 \to \lambda^+$ *such that for every*
   - *ordinal* $\gamma < \lambda^+$, *and every*
   - *subset* $A \subseteq \lambda^+$ *of size* λ^+,

   there exist $\alpha, \beta \in A$ *with* $\alpha < \beta$ *such that* $c(\alpha, \beta) = \gamma$.
2. *There exists a coloring* $c : [\lambda^+]^2 \to \lambda^+$ *such that for every*
   - *positive integer* n,
   - *coloring* $g : n \times n \to \lambda^+$, *and every*
   - *family* $\mathcal{A} \subseteq [\lambda^+]^n$ *of size of* λ^+ *of mutually disjoint sets,*

   there exist $a, b \in \mathcal{A}$ *with* $\max(a) < \min(b)$ *such that* $c(\alpha, \beta) = g(otp(a \cap \alpha), otp(b \cap \beta))$ *for all* $(\alpha, \beta) \in a \times b$.

We shall also discuss models witnessing that the above ZFC result is optimal.

[1] ASSAF RINOT, *Transforming rectangles into squares, with applications to strong colorings*, submitted.

[2] ASSAF RINOT AND STEVO TODORČEVIĆ, *A uniform proof of the rectangular square bracket relation for successor of regulars*, in preparation.

► HIROSHI SAKAI, *Fragments of Martin's Maximum and weak square*.
Graduate School of Engineering, Kobe University, Rokko-Dai 1-1, Nada Kobe, 657-8501, Japan.
E-mail: hsakai@people.kobe-u.ac.jp.

Martin's Maximum has many important consequences such as stationary reflection principles, Chang's Conjecture, etc. On the other hand Martin's Maximum is known to imply the failure of various weak square principles. In this talk we discuss what fragments of Martin's Maximum imply the failure of what kinds of weak square principles.

► DIMA SINAPOVA, *Diagonal extender based Prikry forcing*.
Mathematics Department, University of California at Irvine, Irvine, CA 92697-3875, USA.
E-mail: dsinapov@math.uci.edu.

Extender based Prikry type forcing is one of the most direct ways of violating the Singular Cardinal Hypothesis (SCH). We will describe a construction combining extender based Prikry and diagonal supercompact Prikry forcing. We will discuss its implications on singular cardinal arithmetic, and more precisely the relationship between SCH and combinatorial principles like Jensen's square and scales.

► MIODRAG SOKIC, *Diagonal property (cross-construction) and Ramsey classes*.
Mathematics, Caltech, 253-37, Pasadena, CA 91125, USA.
E-mail: msokic@caltech.edu.

Let OP be the class of finite posets with arbitrary linear ordering and let OU be the class of finite ultrametric spaces with arbitrary linear ordering. There are Fraisse structures OP and OU which are Fraisse limits of OP and OU respectively. In order to calculate universal minimal flow of Aut(OP) and Aut(OU) we introduce the diagonal property(cross-construction). The diagonal property is the technique for obtaining new relational Ramsey classes from the old relational Ramsey structures. This technique is applicable to much wider class of classes.

Abstracts of invited talks in the Special Session on Structural Proof Theory and Computing

► DAVID BAELDE, *A proof theoretical journey from programming to model checking and theorem proving*.
IT University of Copenhagen, Rued Langgaards Vej 7, 2300 Copenhagen S, Denmark.
E-mail: `david.baelde@ens-lyon.org`.

In this talk, we will go through increasingly demanding tasks involving logic. All the way long, focusing provides crucial structure which tightens the connection between logic and computation. Starting from logic programming, we'll see how fixed points bring a more faithful logical account of logic programs, and thus more reasoning capabilities. This will bring general theorem proving capabilities, and some insights on automating it. In between logic programming and theorem proving, we'll encounter model-checking, and some very nice results relating proof theory and automata theory.

► MARCO GABOARDI, *Light logics for polynomial time computations*.
Department of Computer and Information Science, University of Pennsylvania, 3330 Walnut Street, Philadelphia, PA 19104, USA.
E-mail: `gaboardi@cs.unibo.it`.

I overview the Linear Logic approach to Implicit Computational Complexity. I present two different logical systems characterizing the class of polynomial time functions by restricting structural rules. I then point out some results obtained using extensions and generalizations of these structural principles and their use to prove properties of functional programs.

► STEFAN HETZL, *Which proofs can be computed by cut-elimination*?
Institut für Computersprachen, Technische Universität Wien, Favoritenstraße 9/E1852 (Stiege 2/3.Stock), A-1040 Wien, Austria.
E-mail: `hetzl@logic.at`.

In classical logic, it is typically possible to compute significantly different cut-free proofs from a single proof with cuts using a non-deterministic algorithm like Gentzen's procedure based on local proof rewriting steps. I will first speak about results that support this point by relating the number of cut-free proofs thus obtainable to the functions provably total in the system under consideration. Then I will turn towards recent work on characterising the cut-free proofs induced by a given proof with cuts.

► DALE MILLER, *An overview of structural proof theory and computing*.
INRIA Saclay and LIX/Ecole Polytechnique, Palaiseau, France, Laboratoire d'Informatique, LIX, Ecole Polytechnique, Route de Saclay, 91128 Palaiseau, CEDEX France.
E-mail: `dale.miller@inria.fr`.

Structural Proof Theory organizes the presentation of proofs around analytic methods. This field was started with Gentzen when he introduced the LJ and LK sequent calculus proofs systems for intuitionistic and classical logics and significantly strengthen by Girard's introduction of linear logic. This talk will provide an overview of keys ways in which structural proof theory can be used to describe and reason about computing. The description of functional programming using the Curry-Howard correspondence and proof-normalization is familiar to most researchers. We shall also describe how the search for proofs can also be seen as computing and that this framework for presenting computation naturally describes logic programming. The key role of the cut-elimination theorem and the completeness of focused proofs systems will also be illustrated.

► ALEXIS SAURIN, *Proof search and the logic of interaction*.
Laboratoire PPS, CNRS & Université Paris Diderot – Paris 7, Case 7014, 75205 Paris Cedex 13, PPS, University of Paris 7, France.
E-mail: alexis.saurin@pps.jussieu.fr.

Proof theory deeply impacted two main paradigms of declarative programming laguages, namely logic programming and functional programming. This influenced the design of programming languages as well as the analysis of program behaviours: the most striking example of this interplay is probably the Curry-Howard correspondence unveiled 40 years ago.

Considering the aforementioned connections between logic and programming, one may expect that a better understanding of the essence of proofs will provide more sophisticated tools for analyzing programs. Ludics has been introduced in 1999 by J.-Y. Girard, building on research undertaken in the previous two decades on linear logic, the geomerty of interaction as well as game-theoretical interpretations of logic and programming languages. Ludics can be described as a reconstruction of logic from the concept of interaction.

After providing backgound on this interactive approach, I will explain how the interactive approach to logic and proof theory suggests new directions for computation as proof-search.

Abstracts of contributed talks

► KUANYSH ABESHEV, *On the existence of universal numberings for families of d.c.e. sets*.
Department of Mathematics of Kazakh National University, 71 Al-Farabi Avenue, Almaty 050038, Kazakhstan.
E-mail: kuanqk@gmail.com.

We investigate properties of universal numberings of finite families of d.c.e. sets. We show different cases of finite families of d.c.e. sets for which there is a universal numbering and for which there is not.

[1] S. A. Badaev and S. S. Goncharov, *The theory of numberings: Open problems*, (P. A. Cholak, S. Lempp, M. Lerman, and R. A. Shore, editors), ***Computability theory and its applications***, Current Trends and Open Problems, American Mathematical Society, Providence, 2000, pp. 23–38.

[2] Yu. L. Ershov, *Theory of numberings*, ***Handbook of computability theory***, North-Holland, Amsterdam, 1999, pp. 473–503.

► DAVID BELANGER, *Weak truth table degrees of structures*.
Department of Mathematics, Cornell University, 105 Malott Hall, Ithaca, NY 14853-4201, USA.
E-mail: dbelange@math.cornell.edu.

The weak truth table (wtt) degree spectrum of a first-order relational structure $\mathcal{A}$ is the set of all wtt-degrees of atomic diagrams of isomorphic copies of $\mathcal{A}$. We present new results on wtt spectra, among them a dichotomy along the lines of Knight's upward-closure theorem for Turing degree spectra [1], and some properties contrasting the wtt degree spectra of finite- and infinite-signature structures. We show that, as a method of defining classes of reals except in trivial cases, the wtt degree spectrum is strictly more expressive than the Turing degree spectrum.

[1] Julia Knight, *Degrees coded in jumps of orderings*, ***The Journal of Symbolic Logic***, vol. 51 (1986), no. 4, pp. 1034–1042.

► DENNIS F. CUDIA, *The Boltzmann principle and degeneracy I*.
5343 Cunningham Road, Rockford, IL 61102, USA.

The following unambiguous context free grammar G_m has productions based on the five degeneracies $1, 2, 3, 4, 6$ of the genetic code. $L(G_m)$ is the set of $\langle$initiation$\rangle$ followed by any positive integer number of codons followed by $\langle$termination$\rangle$.

$\langle\text{Strt}\rangle \to \langle\text{initiation}\rangle\ S'\ \langle\text{termination}\rangle$
$S' \to \langle\text{initiation}\rangle\ S' \mid \langle\text{codon}\rangle$
$\langle\text{codon}\rangle \to \mathrm{D}_1 \mid \mathrm{D}_2 \mid \mathrm{D}_3 \mid \mathrm{D}_4 \mid \mathrm{D}_6$
$\mathrm{D}_1 \to \mathtt{AUG} \mid \mathtt{UGG}$
$\mathrm{D}_2 \to \mathtt{UUY} \mid \mathtt{UAY} \mid \mathtt{CAY} \mid \mathtt{CAR} \mid \mathtt{AAY} \mid \mathtt{AAR} \mid \mathtt{GAY} \mid \mathtt{GAR} \mid \mathtt{UGY}$
$\mathrm{D}_3 \to \mathtt{AUU} \mid \mathtt{AUC} \mid \mathtt{AUA}$
$\mathrm{D}_4 \to \mathtt{GUN} \mid \mathtt{CCN} \mid \mathtt{ACN} \mid \mathtt{GCN} \mid \mathtt{GGN}$
$\mathrm{D}_6 \to \mathtt{UCY} \mid \mathtt{UCR} \mid \mathtt{AGY} \mid \mathtt{CUY} \mid \mathtt{CUR} \mid \mathtt{UUR} \mid \mathtt{CGY} \mid \mathtt{CGR} \mid \mathtt{AGR}$
$\mathrm{N} \to \mathtt{Y} \mid \mathtt{R}$
$\mathtt{Y} \to \mathtt{U} \mid \mathtt{C}$
$\mathrm{R} \to \mathtt{A} \mid \mathtt{G}$

Given any mature mRNA, mr, let N_1, N_2, N_3, N_4, N_6, resp., be the number of codons in mr of degeneracy $1, 2, 3, 4, 6$, resp., and let $x = \sum \mathrm{N}_i$. For each non-terminal X of $\mathtt{G}_m$ define the *syntactic information of* X, $SI(X)$, by $SI(X) = \ln W(X)$ where $W(X)$ is the number of righthand sides of X. For a generation tree for mr the *syntactic information of* mr is denoted by $SI(\mathrm{N}_i)$ and $SI(\mathrm{N}_i) = \alpha \ln 2 + \beta \ln 3 + (x + \mathrm{N}_4) \ln 5$ where $\alpha = 2x + \mathrm{N}_4 - \mathrm{N}_3$ and $\beta = 2\mathrm{N}_2 + \mathrm{N}_3 + 2\mathrm{N}_6$. Let $\overline{SI}(\mathrm{N}_i) = SI(\mathrm{N}_i)/x$, and $\overline{S}(\mathrm{N}_i)$ be the intensive entropy of mixing. Starting from a set of nine polypeptides the regression line of $\overline{SI}(\mathrm{N}_i)$ on $\overline{S}(\mathrm{N}_i)$ is found to have sample correlation coefficient $r = -.911$.

► FRANÇOIS DORAIS, JEFFRY HIRST, AND PAUL SHAFER, *Reverse mathematics and field extensions* (Preliminary Report).
Department of Mathematical Sciences, Appalachian State University, Boone, NC 28608, USA.
E-mail: doraisfg@appstate.edu.
E-mail: hirstjl@appstate.edu.
URL Address: www.mathsci.appstate.edu/~jlh.
E-mail: shaferpe@appstate.edu.

We will report on recent work exploring the reverse mathematics of algebraic field extensions. Topics considered will include existence theorems for automorphisms and other isomorphisms between algebraic extensions and an analysis of various definitions of normal field extensions.

► MONROE ESKEW, *Generalization by collapse*.
Department of Mathematics, University of California at Irvine, 340 Rowland Hall, Irvine, CA 92617, USA.
E-mail: meskew@math.uci.edu.

We present a technique for generalizing theorems about ideals on small cardinals to ideals on larger cardinals. The idea is essentially due to Gitik. As an illustration, we show how this technique can be used to prove Ulam's classical theorem that any κ^+-complete ideal on κ^+ is not κ^+-saturated. We then present two new results, both generalizing theorems about consequences of the existence of a uniform, countably complete, ω_1-dense ideal on ω_2. First, Woodin proved that the existence of such an ideal on ω_2 implies CH. We show that for any κ, the existence of an analogous ideal on κ^{++} implies $2^\kappa = \kappa^+$. This answers a question of Foreman posed in the Handbook of Set Theory. Second, Foreman proved that the existence of such an ideal on ω_2 implies the existence of a uniform ultrafilter on ω_2 yielding an ultrapower of ω with the smallest possible size, ω_1. We show that the existence of an analogous ideal on κ^{++} implies the existence of a uniform ultrafilter U on κ^{++} such that $|\kappa^{\kappa^{++}}/U| = \kappa^+$, again the smallest possible size.

[1] MATTHEW FOREMAN, *Ideals and generic elementary embeddings*, ***Handbook of set theory*** (Matthew Foreman and Akihiro Kanamori, editors), Springer, 2010, pp. 885–1147.

[2] Moti Gitik and Saharon Shelah, *Forcings with ideals and simple forcing notions*, ***Israel Journal of Mathematics***, vol. 68 (1989), no. 2, pp. 129–160.

[3] W. Hugh Woodin, ***The axiom of determinacy, forcing axioms, and the nonstationary ideal***, de Gruyter Series in Logic and its Applications, 1, Walter de Gruyter, 2010.

► GREG HJORTH AND IOANNIS SOULDATOS, *Independently axiomatizable $L_{\omega_1,\omega}$ theories*.
Department of Mathematics and CSSE, University of Detroit Mercy, 4001 W. McNichols Road, Detroit, MI 48221-3038, USA.
E-mail: souldaio@udmercy.edu.

A set of sentences T' is called *independent* if for every $\phi \in T'$, $T' \setminus \{\phi\} \nvDash \phi$. A theory T is called *independently axiomatizable*, if there is a set T' which is independent and T and T' have exactly the same models.

We will review a couple of known theorems for the case that $T \subset L_{\omega,\omega}$ and present sufficient conditions for an $L_{\omega_1,\omega}$ theory to have an independent axiomatization. As a consequence we obtain two corollaries: The first, assuming Vaught's Conjecture, every $L_{\omega_1,\omega}$ theory in a countable language has an independent axiomatization. The second, this time outright in ZFC, every intersection of a family of Borel sets can be formed as the intersection of a family of *independent* Borel sets.

Professor Hjorth passed away on 01/13/2011. This talk is dedicated to his memory.

[1] G. Hjorth and I. Souldatos, *Independently axiomatizable $L_{\omega_1,\omega}$ theories*, ***The Journal of Symbolic Logic***, vol. 74 (2009), no. 4, pp. 1273–1286.

► LU LIU (JIAYI LIU), *Combinatorial property vs computational property*.
Department of Mathematics, Central South University, LuShan South Road, ChangSha 410083, China.
E-mail: g.jiayi.liu@gmail.com.

A set C can be strongly coded under condition $\langle \mathcal{B}, \mathcal{C}(A)\rangle$, where $\mathcal{B}$ and $\mathcal{C}$ are classes of sets possibly with other parameters, iff there exists $A \in \mathcal{B}$ such that every $Z \in \mathcal{C}(A)$ can be used to compute C. The issue is widely studied especially in effective mathematics and reverse mathematics. We focus on three kinds of conditions, namely, density condition, enumeration condition and partition condition. For density condition and enumeration condition, we give necessary and sufficient conditions for the parameters that ensure, under the corresponding coding condition $\langle \mathcal{B}, \mathcal{C}(A)\rangle$ any set can be strongly computed. As a corollary, we show that for any given $C >_T 0$, if we restrict A to have at least constant density then there exists an infinite subset of A that can not be used to compute C. This is in contrast with a well-known result that if A is allowed to have density that approaches to 0, then for any C there exists A such that C can be computed by any infinite $G \subseteq A$. In addition we give a simplified proof of a main theorem of Greenberg and Miller using a combinatorial result used in the proof of above theorem. As to enumeration condition we also give necessary and sufficient condition for a degree that can be strongly coded under corresponding condition. The last condition we study is partition condition. We give applications of our results including RT^2_2 does not imply WWKL_0.

► DAVID MILOVICH, *Forbidden local bases*.
Texas A& M International University, 5201 University Boulevard, Laredo, TX 78041, USA.
E-mail: david.milovich@tamiu.edu.

The Chang conjecture $(\aleph_{\omega+1}, \aleph_\omega) \twoheadrightarrow (\aleph_1, \aleph_0)$ is known to refute the existence of a locally countable local base in $2^{\aleph_\omega}$ with the countably supported box product topology. Locally countable here means that no uncountable subset of the local base intersects to contain an element of the local base. However, Kojman, Spadaro, and myself have shown in ZFC that a locally $(\leq \aleph_3)$ global base exists for this space.

I also have established negative results about "rectangular" local bases in compacta. For example, there is no compactum where all points have local bases of cofinal type $\omega \times \omega_2$. The same goes for any finite product of infinite cardinals, except those of the form $\omega \times \cdots \times \omega_n$, for which $2^{\omega}_{\text{lex}} \times \cdots \times 2^{\omega_n}_{\text{lex}}$ is a counterexample. The question of whether a homogeneous counterexample exists is of interest because rectangular local bases imply lower bounds on cellularity, and it is unknown if homogeneous compacta can have cellularity exceeding $\mathfrak{c}$.

► JOSEPH W. NORMAN, *Saving truth from orthodoxy: better logic through algebra, probability, and dynamical systems*.
Department of Internal Medicine, University of Michigan, 1500 East Medical Center Drive, Ann Arbor, MI 48109, USA.
E-mail: `jwnorman@umich.edu`.

A new framework of paraconsistent and paracomplete logic resolves paradoxes and undecidability in classical logic. The key is differentiating between several classes of mathematical systems: arithmetical, algebraic, probabilistic, and dynamical. Each class has its own 'codomain of evaluation' (the set of possible values of its expressions, constructed from elementary values) and its own style of inference. For example, in arithmetic every expression has an elementary numeric value ($1+1\times 0$ is 1) and inference follows the pattern of sequential transformation ($1 + 1 \times 0$ yields $1 + 0$; then $1 + 0$ yields 1). But in algebra the solutions to equations are *sets* of elementary values (given $x = x^2$ the solution for x is $\{0, 1\}$) and the style of inference is constraint satisfaction (to solve for y given $x = x^2$, $y = y^2$, $x = 1$, and $xy - x + 1 = 1$, the equations are considered simultaneously).

Classical logic confuses different systems: it promises algebra and dynamics (axioms are equations; self-references are recurrence relations) but expects the resulting algebraic and dynamical systems to follow the rules of simple arithmetic. This confusion is manifest in misguided principles: the excluded middle, explosion from contradiction, and even *modus ponens* as a rule of inference. Nonetheless, we need not be mystified by truth values that are not elementary values like 0 or 1 accompanied by traditional proofs—but instead are structures computed by solving equations, like the sets $\{0, 1\}$ and $\{\}$ or the dynamical system $0 \rightleftarrows 1$. Using algebra, probability, and dynamical systems it is possible to define logical truth and consequence in a sensible and computable manner that precludes the old paradoxes, obviates undecidability, and clarifies alethic modalities.

► JUSTIN PALUMBO, *Dominating and unbounded reals in Hechler extensions*.
Department of Mathematics, University of California at Los Angeles, Los Angeles, CA 90095, USA.
E-mail: `justinpa@math.ucla.edu`.

Hechler forcing is the most basic tool for adding a dominating real to the universe, and several variations have been studied in the literature, see for example [1], [2], [3]. We present results exploring the relationship between dominating and unbounded reals in these forcing extensions. We will show that in the tree Hechler extension every unbounded real is infinitely often above some dominating real, while in the standard Hechler extension there is an unbounded real eventually below every dominating real. As a corollary we negatively settle conjecture 15 of [2]. We also obtain the following representation theorem for the dominating reals in the Hechler extension.

THEOREM. *Let d be a Hechler real and let $y \in V[d]$ be a dominating real. Then there are nondecreasing ground model reals z_0, z_1 which go to infinity and so that y eventually dominates $z_0 \circ d \circ z_1$.*

This representation theorem has several consequences on the structure of dominating reals in the Hechler extension. For example, it implies that any countable family of dominating reals has a dominating lower bound in the reverse domination order and furthermore that the dominating reals in the reverse domination order have a structure essentially isomorphic to those of the ground model reals in the domination order. The latter provides an answer to a question of [4].

[1] TOMEK BARTOZYŃSKI AND HAIM JUDAH, ***Set Theory. On the structure of the real line***, A K Peters, 1995.

[2] JÖRG BRENDLE AND BENEDIKT LÖWE, *Eventually different functions and inaccessible cardinals*, ***Journal of the Mathematical Society of Japan***, vol. 63 (2011), no. 1, pp. 137–151.

[3] JÖRG BRENDLE, HAIM JUDAH AND SAHARON SHELAH, *Combinatorial properties of Hechler forcing*, ***Annals of Pure and Applied Logic***, vol. 58 (1992), no. 3, pp. 185–199.

[4] CLAUDE LAFLAMME, *Bounding and dominating number of families of functions on* ω, ***Mathematical Logic Quarterly***, vol. 40 (1994), no. 2, pp. 207–223.

► WIM RUITENBURG, *Intuitionistic quantifier elimination and model completeness*.
Department of Mathematics, Marquette University, P.O. Box 1881, Milwaukee WI 53201, USA.
E-mail: wimr@mscs.mu.edu.

There are different ways to define intuitionistic quantifier elimination, and different ways to define intuitionistic model completeness. Starting from examples that are motivated by the papers mentioned below, we discuss how some classical model theoretic results apply in these contexts.

[1] BEN ELLISON, JONATHAN FLEISCHMANN, DAN MCGINN, AND WIM RUITENBURG, *Quantifier elimination for a class of intuitionistic theories*, ***Notre Dame Journal of Formal Logic***, vol. 49 (2008), no. 3, pp. 281–293.

[2] WIM RUITENBURG, *Very intuitionistic theories and quantifier elimination*, ***The Review of Modern Logic***, vol. 10 (2004/05), no. 1–2, pp. 99–112.

► SAM SANDERS, *Reuniting the antipodes: bringing together Nonstandard Analysis and Constructive Analysis*.
Department of Mathematics, Ghent University, Krijgslaan 281, 9000 Gent, Belgium.
E-mail: sasander@cage.ugent.be.
URL Address: http://cage.ugent.be/~sasander.

Constructive Analysis was introduced by Errett Bishop to identify the *computational meaning* of mathematics. In the spirit of intuitionistic mathematics, notions like *algorithm*, *explicit computation*, and *finite procedure* are central. The exact meaning of these vague terms was left open, to ensure the compatibility of Constructive Analysis with several traditions in mathematics. Constructive Reverse Mathematics (CRM) is a spin-off of Harvey Friedman's famous *Reverse Mathematics* program, based on Constructive Analysis. Bishop famously derided Nonstandard Analysis for its lack of computational meaning. In this talk, we introduce 'Ω-invariance': a simple and elegant definition of *finite procedure* in (classical) Nonstandard Analysis. Using an intuitive interpretation, we obtain many results from CRM, thus showing that Ω-invariance is quite close to Bishop's notion of *finite procedure* and algorithm.

This research is generously sponsored by the John Templeton Foundation.

► MATTHEW SMEDBERG, *A dense family of finite 1-generated distributive groupoids*.
Department of Mathematics, Vanderbilt University, 1227 Stevenson Center, Nashville, TN 37240, USA.
E-mail: matthew.smedberg@vanderbilt.edu.

Nonassociative groupoids obeying the left-distributive (LD) axiom $x(yz) = (xy)(xz)$ have found powerful application in set theory, as well as in group theory, geometric topology, and elsewhere. However, until now, their study has been hampered by the chaotic combinatorics of even the finite members of this class. In this talk I will exhibit a subfamily of finite LD groupoids which admit every 1-generated finite LD groupoid as a homomorphic image; the structure theory of this family is much less complex than that of arbitrary finite

1-generated LD groupoids, making possible (I hope) a resolution of outstanding problems of Richard Laver and Patrick Dehornoy, which I will indicate at the end.

[1] MATTHEW SMEDBERG, *A dense family of well-behaved monogenerated LD groupoids*, ***The Journal of Symbolic Logic***, submitted.

▶ DAN E. WILLARD, *An unusual reflection principle for self-justifying logics*.
Computer Science & Mathematics Departments, University at Albany, Albany, NY 12222, USA.
E-mail: dew@cs.albany.edu.

This article will explain how a new type of reflection principle is applicable to a series of results about generalizations and boundary-case exceptions for the Second Incompleteness Theorem that we have published in six papers in the *JSL* and *APAL*. Let Π_1^- denote the analog of an arithmetic Π_1 sentence in [1, 2]'s "Grounding" language L^- that treats multiplication as a 3-way relation (and also treats addition as a similar non-total function in [2]). If (α, d) denotes an axiom system and deduction method, then let $\text{SelfCons}^1(\alpha, d)$ be the following self-referencing statement:

> "There exists no two proofs (using deduction method d) of *both* some Π_1^- sentence and its negation, from the union of the axiom system α with *this* added sentence "$\text{SelfCons}^1(\alpha, d)$" (*looking at itself*)."

Let β denote the axiom system of $\alpha + \text{SelfCons}^1(\alpha, d)$. The Second Incompleteness Theorem implies that β will be inconsistent (and thus useless) for most inputs (α, d). However, [1, 2] have documented four unusual paradigms where (α, d) is weak enough to generate a boundary-case exception to the Second Incompleteness Theorem.

Let $\text{Prf}_\beta^d(\ulcorner\Psi\urcorner, p)$ represent the usual expression denoting p is a proof of Ψ from axiom system β using d's deduction method. Also, let T denote a mapping from a Π_1^- sentence Ψ to a second Π_1^- sentence Ψ^T that is equivalent to Ψ under arithmetic's standard model. Then [3]'s new Theorem 6.12 establishes that if β is consistent then there exists primitive recursive mappings T where Equation 1's reflection principle is provable from β. This is surprising because the Incompleteness Theorem implies no analog of (1) is provable from β when T is the identify mapping. (Theorem 6.12 thus requires that β not know Ψ and Ψ^T are equivalent under the standard model.)

$$\forall p\,[\text{Prf}_\beta^d(\ulcorner\Psi\urcorner, p) \Rightarrow \Psi^T]. \tag{1}$$

[1] D. WILLARD, *An exploration of the partial respects in which an axiom system recognizing solely addition as a total function can verify its own consistency*, ***The Journal of Symbolic Logic***, vol. 70 (2005), pp. 1171–1209.

[2] ———, *A generalization of the Second Incompleteness Theorem and some exceptions to it*, ***Annals of Pure and Applied Logic***, vol. 141 (2006), pp. 472–496.

[3] ———, *A detailed examination of methods for unifying, simplifying and extending several results about self-justifying Logics*, http://arxiv.org/abs/1108.6330.

Abstracts of talks presented by title

▶ JOHN CORCORAN, *Heinrich Scholz on Aristotle's underlying logic*.
Philosophy, University at Buffalo, Buffalo, NY 14260-4150, USA.
E-mail: corcoran@buffalo.edu.

Different scholars working independently in the 1970s are currently credited with discovering that Aristotle's syllogistic was an *underlying logic* embodying deductive reasoning intended to obtain theorems from axioms of axiomatic sciences—as in pre-Euclidean geometry ([3, p. xvi]). The expression 'underlying logic' had been introduced by Alonzo Church in the 1950s ([1, pp. 57–58 and 317–329]). Aristotle's rules of sentence and deduction formation were so detailed that strong completeness results were obtained—an underlying logic is *strongly complete* if every sentence satisfied by all models of given premises is obtainable from those premises using the logic's rules. The thesis that Aristotle's syllogistic was an underlying logic contradicted all previous views of the syllogistic, e.g., that it was an axiomatic science presupposing a hidden underlying logic or that it was a system of "reductions" as described in the medieval mnemonics BARBARA, CELARENT, etc.

We show that in 1931 Heinrich Scholz ([2, pp. 3, 5, 6, and 17]) had stated clearly that Aristotle's syllogistic was an underlying logic—of course without using the expression 'underlying logic'. On page 5 Scholz wrote that "logic is to formulate the rules by whose application the theorems of a science may be derived from [...] axioms". And on page 6, he said that a logic cannot be an axiomatic science because it would have to axiomatize itself and it would be incomprehensible how the rules of deduction could be derived. Unfortunately, Scholz did not describe the Aristotelian rules he had in mind.

[1] Alonzo Church, ***Introduction to mathematical logic***, Princeton University Press, Princeton, 1956.
[2] Heinrich Scholz, ***Concise history of logic***, Philosophical Library, New York, 1931/1961.
[3] Robin Smith, ***Aristotle's prior analytics***, Hackett, Indianapolis, 1989.

► JOHN CORCORAN AND WILLIAM FRANK, *Surprises in logic*.
Philosophy, University at Buffalo, Buffalo, NY 14260-4150, USA.
E-mail: corcoran@buffalo.edu.

There are many surprises in logic. Peirce gave us a few. Russell gave Frege one. Löwenheim gave Zermelo one. Gödel gave some to Hilbert. Tarski gave us several.

When we get a surprise, we are often delighted, puzzled, or skeptical. Sometimes we feel or say "Nice!", "Wow, I didn't know that!", "Is that so?", or the like.

Every surprise belongs to someone. There are no disembodied surprises. Saying there are surprises in logic means that logicians experience surprises doing logic—not that among logical propositions some are intrinsically or objectively "surprising".

The expression "That isn't surprising" often denigrates logical results.

Logicians often aim for surprises. In fact, [1] argues that logic's potential for surprises helps motivate its study and, indeed, helps justify logic's existence as a discipline.

Besides big surprises that change logicians' perspectives, the logician's daily life brings little surprises, e.g., that Gödel's induction axiom alone implies Robinson's axiom. Sometimes wild guesses succeed. Sometimes promising ideas fail. Perhaps one of the least surprising things about logic is that it is full of surprises.

Against the above is Wittgenstein's surprising conclusion ([2, 6.1251]): "Hence there can never be surprises in logic".

This paper unearths basic mistakes in [2] that might help to explain how Wittgenstein arrived at his false conclusion and why he never caught it. The mistakes include: unawareness that surprise is personal, confusing logicians having certainty with propositions having logical necessity, confusing definitions with criteria, and thinking that facts demonstrate truths. People demonstrate truths using their deductive know-how and their *knowledge* of facts: facts *per se* are epistemically inert.

[1] John Corcoran, *Hidden consequence and hidden independence*, ***The Bulletin for Symbolic Logic***, vol. 16 (2010), p. 443.
[2] Ludwig Wittgenstein, ***Tractatus Logico-Philosophicus***, Kegan Paul, London, 1921.

► JOHN CORCORAN AND MATT LAVINE, *Discovering string theory*.
Philosophy, University at Buffalo, Buffalo, NY 14260-4150, USA.
E-mail: corcoran@buffalo.edu.
E-mail: mattlavi@buffalo.edu.

String theory—theoretical syntax or *concatenation theory*—studies *strings* of *characters*.

We discuss the discovery of its subject matter, its basic concepts, and its basic laws. We also treat logic's awakening need for it, the creation of its axiomatizations, and the recognition of its foundational importance.

Logicians manipulated strings long before explicitly discussing string-manipulation. Later logicians recognized *syntactic* operations: concatenating, prefixing, suffixing, transposing, replacing, substituting, detaching, deleting, interchanging, etc. The idea that certain logically-relevant relations were analogous to certain string relations came later: e.g., converses result from interchanging. It became clear that strings had an important role in logic and metalogic.

Mathematically-inclined logicians noticed that string concatenation resembled number addition: both are homogeneous, associative, totally-defined, two-place operations. Another step was discovery that strings-under-concatenation gives rise to mathematical theories analogous to theories of numbers-under-addition. Logicians then realized that the axiomatic tradition traced to Euclid's predecessors required such theories be treated axiomatically. In 1956 Alonzo Church ([1, p. 59]) wrote:

> Like any branch of mathematics, theoretical syntax may, and ultimately must, be studied by the axiomatic method.

Church was evidently unaware that string theory already had two axiomatizations from the 1930s ([2, p. 625]): one by Hans Hermes and one by Alfred Tarski. Coincidentally, the first English presentation of Tarski's 1933 axiomatic foundations of string theory ([3, pp. 173–174]) appeared in 1956—the same year that Church called for such axiomatizations.

[1] ALONZO CHURCH, ***Introduction to Mathematical Logic***, Princeton University Press, Princeton, 1956.

[2] JOHN CORCORAN, WILLIAM FRANK, AND MICHAEL MALONEY, *String theory*, ***The Journal of Symbolic Logic***, vol. 39 (1974), pp. 625–637.

[3] ALFRED TARSKI, *The concept of truth in formalized languages*, ***Logic, Semantics, Metamathematics***, Hackett, Indianapolis, 1983, pp. 152–278.

► JOHN CORCORAN AND JUSTIN LEGAULT, *One-place plural predicates in Aristotle's logic*.

Philosophy, University at Buffalo, Buffalo, NY 14260-4150, USA.
E-mail: corcoran@buffalo.edu.

Today's logicians recognize varieties of singular predicates: one-place, two-place, three-place, four-place, etc. *Socrates thinks* has a one-place singular predicate, *Socrates teaches Plato* two-place, *Plato is between Socrates and Aristotle* three-place, and *Socrates is to Plato as Aristotle is to Theophrastus* four-place—all singular, none plural. Varieties of singular predicates were not treated before modern times.

However, somewhat-related varieties of *one-place plural predicates* OPPPs are in Aristotle's logic starting on page one (***Categories***, 1a1). We discuss three varieties of OPPPs that we call *polymonadic*, *monodyadic*, and *polydyadic*.

A *polymonadic* OPPP applies to things *severally* and distributes over them *individually*: saying that several propositions *are true* amounts to saying that each *is true*. *Are true* is a polymonadic OPPP as is Aristotle's *are paronymous*.

A *monodyadic* OPPP applies only to two things pairwise; it cannot apply severally. Saying two propositions *are contrary* amounts to saying each is a contrary opposite of the other. *Are contrary* is a monodyadic OPPP as is Aristotle's *are contradictory*. A monodyadic OPPP has no corresponding singular form: we don't say *one proposition is contrary*. Moreover, applying monodyadic OPPPs to more than two things is an incoherent category mistake. We don't say *three propositions are contrary*.

A *polydyadic* OPPP applies to only things in pairs but it can apply severally. When applied to things severally it distributes over them pairwise: saying that several propositions *are equivalent* amounts to saying that every two of them are equivalent. *Are equivalent* is a polydyadic OPPP as are Aristotle's *are homonymous*, *are synonymous*, and *are equal*.

Supplementing two lectures abstracted in this BULLETIN, *Predicates and predications*, forthcoming, and *Predications in ancient logic*, forthcoming, we survey one-place plural predicates in Aristotle and his recent commentators.

► JOHN CORCORAN AND SRIRAM NAMBIAR, *Surprising universal para-counterexample numbers*.
Philosophy, University at Buffalo, Buffalo, NY 14260-4150, USA.
E-mail: corcoran@buffalo.edu.

This self-contained expository lecture continues presentations abstracted in this BULLETIN, vol. 13 (2007), p. 294, and vol. 11 (2005), p. 460 and pp. 554–555. Consider a first-order language with identity interpreted in the natural numbers so every number is denoted by some numeral. A number n is a *counterexample* for the universal proposition $\forall x\, \mathrm{P}(x)$ iff n satisfies $\sim \mathrm{P}(x)$. A universal proposition is false iff it has a counterexample.

Obviously there are no "universal counterexample numbers": no single number is a counterexample for every false universal proposition [about numbers]. No even number is a counterexample for "every number is even" and no odd number is a counterexample for "every number is odd".

However, as shown in above-mentioned abstracts, some numbers *not* counterexamples for a given proposition nevertheless *are* counterexamples for some of its logical equivalents.

Could there be a number that is a counterexample for logical equivalents of *all* false universal propositions? To restate this question unambiguously define a number to be a *para-counterexample* for $\forall x\, \mathrm{P}(x)$ iff it is a counterexample for some universal $\forall x\, \mathrm{Q}(x)$ logically equivalent to $\forall x\, \mathrm{P}(x)$. And define a number to be a *universal para-counterexample* iff it is a para-counterexample for every false universal proposition [about numbers].

If n is a universal para-counterexample and $\forall x\, \mathrm{P}(x)$ is an arbitrary false universal proposition, then either n is a counterexample for $\forall x\, \mathrm{P}(x)$ or n is a counterexample for some other false universal proposition $\forall x\, \mathrm{Q}(x)$ logically equivalent to $\forall x\, \mathrm{P}(x)$.

Are there universal para-counterexample numbers?

UNIVERSAL-PARA-COUNTEREXAMPLE-NUMBER THEOREM. Every number is a universal para-counterexample.

PROOF SKETCH. Let n^* be a numeral for n. $\forall x\, P(x)$ is logically equivalent to $\forall y\,(y = n^* \rightarrow \forall x\, P(x))$, which has n as a counterexample if $\forall x\, P(x)$ is false.

► JOHN CORCORAN AND ANTHONY RAMNAUTH, *Equality and identity*.
Philosophy, University at Buffalo, Buffalo, NY 14260-4150, USA.
E-mail: corcoran@buffalo.edu.

Two line halves are *equal* but not *identical* [one and the same]. Every line *equals* infinitely many other lines, but no line *is* [identical to] any other line—taking 'identical' strictly here and below.

Knowing that two lines *equaling* a third are equal is useful; the condition "two lines equaling a third" often holds. But could knowing that two lines *being* [identical to] a third are identical be useful? The antecedent condition "two things identical to a third" never holds, nor does the consequent condition "two things being identical".

The plural predicate 'are equal' as in 'All diameters of a given circle are equal' is useful and natural. 'Are identical' as in 'All centers of a given circle are identical' is awkward or worse.

Substituting equals for equals [replacing one of two equals by the other] makes sense. Substituting identicals for identicals is empty—a thing is identical only to itself; substituting one thing for itself leaves that thing alone, does nothing.

There are as many types of equality as magnitudes: angles, lines, planes, solids, times, etc. Each admits unit magnitudes. And each such *equality* analyzes as *identity* of magnitude: two lines are equal [in length] if the one's length is identical to the other's.

Tarski [1] hardly mentioned equality-identity distinctions (pp. 54–63). His discussion begins:

> Among the logical concepts [. . .], the concept of IDENTITY or EQUALITY [. . .] has the greatest importance.

Not until page 62 is there an equality-identity distinction. His only "notion of equality", if such it is, is geometrical congruence—having the same size and shape—an equivalence relation not admitting any unit.

This lecture treats the history and philosophy of equality-identity distinctions.

[1] ALFRED TARSKI, ***Introduction to logic***, Dover, New York, 1995.

► CYRUS F. NOURANI, *Competitive models, compatibility, game tree degrees, and projective geometry on random sets*.

PO Box 190762, San Francisco, CA 94119, USA.
URL Address: `Akdmkrd.tripod.com` .
E-mail: `cyrufn@alum.mit.edu`.
E-mail: `Akdmkrd@mail.com`.

Modeling game trees compatibility is defined on Random Sets where the correspondence between compatibility on random sets and game degrees are applied to present random model diagrams. Random diagram game degrees are applied and model ranks based on satisfiability computability to optimal ranks are examined. *A model is a competing model iff at each stage the model is compatible with the goal tree satisfiability criteria*. In computational geometry, a standard technique to build a structure like a convex hull is to randomly permute the input points and then insert them one by one into the existing structure. A set is random if it is Martin-Löf random relative to $(n-1)$: that is then encoded relative to infinite initial segments compressors, e.g., W. Merkle and N. Mihailovic JSL 2004. Measure plausible ranks assignments to Possible Worlds (author ASL 1994 and author Descriptive Definability, CSIT, Russia, 2004). Define plausible diagrams that can encode random worlds where a formula is true iff it is true with all such random assignments.

PROPOSITION. Computational geometry can be characterized on random sets as a projection to a Boolean valued function on random diagrams on the corresponding geometry to a product random set.

DEFINITION. A random diagram game tree is a game tree where assignments to variables is defined on a Boolean function on a specified random set. We can then rank models based on game-tree satisfiability on a specific game tree degree. Thus we have a the model closest to a win when ranks higher on satisfiability.

THEOREM 1. *There are computable models where optimal ranks can be determined.*

THEOREM 2. *Based on computable models with computable diagrams model compatibility is effectively computable.*