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11TH ASIAN LOGIC CONFERENCE

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The 11th Asian Logic Conference was held June 22–27, 2009 at the National University of Singapore (NUS), Singapore. The conference was in honor of Professor Chitat Chong's 60th birthday and also celebrated the 80th anniversary of the Faculty of Science, NUS. Funding was provided by: the Association for Symbolic Logic; Institute for Mathematical Sciences, Faculty of Science and Provost Office of NUS; and, World Scientific Publisher. The Program Committee consisted of Rod Downey, Qi Feng (Chair), Byunghan Kim, Theodore A. Slaman, Akito Tsuboi, W. Hugh Woodin, and Yue Yang. The members of the Local Organizing Committee were Qi Feng, Frank Stephan, Guohua Wu, and Yue Yang (Chair), with Ms. Stella Pang as Secretariat.

The program consisted of seventeen one-hour plenary talks given by Klaus Ambos-Spies, Toshiyasu Arai, Bektur Baizhanov, John T. Baldwin, Rod Downey, Ilijas Farah, Renling Jin, Iskander Sh. Kalimullin, Peter Koellner, Manuel Lerman, Menachem Magidor, Michael Rathjen, Gerald E. Sacks, Stephen G. Simpson, Theodore A. Slaman, Frank Stephan, and W. Hugh Woodin. The program also included thirty-one contributed talks (twenty minutes each).

There were 86 registered participants from Canada, China, Germany, India, Israel, Japan, Kazakhstan, New Zealand, Poland, Russia, Singapore, South Korea, Spain, Chinese Taipei, the United Kingdom, and the United States.

Abstracts of the invited talks and contributed talks given by members of the Association for Symbolic Logic follow.

For the Programming and Organizing Committees
QI FENG AND YUE YANG

Abstracts of invited plenary talks

► KLAUS AMBOS-SPIES, *Weak completeness notions for exponential time*.
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The common way for proving a problem to be intractable is to show that the problem is hard or complete for one of the standard complexity classes containing intractable problems. In the 1990s Lutz raised the question whether this approach to intractability can be generalized by considering more general *weak* completeness notions which still imply intractability. While

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for a complete set A for a class C all problems in C can be reduced to A, Lutz proposed to call a set A weakly complete if a *nonnegligible* part of C can be reduced to A. For the exponential-time class $\mathrm{E} = \mathrm{DTIME}(2^{lin})$, Lutz formalized these ideas by introducing a resource bounded measure on this class and by saying that a subclass of E is negligible if it has measure 0 in E.

In our talk we will introduce and discuss some more general weak completeness notions for E which do not require a measure concept but can be defined in terms of the basic concepts of computational complexity theory.

► TOSHIYASU ARAI, *Provably Δ^0_2 and weakly descending chains of ordinals*.
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Let T be a theory for which an ordinal analysis has been established. Specifically suppose that we have a standard well ordering for the proof-theoretic ordinal of T. Then we show that a set is provably Δ^0_2 in T iff it is T-provably in the class D_α of α-r.e. sets in the Ershov hierarchy for an α in the standard well ordering.

The only-if part is proved by extracting a weakly descending chain of ordinals from a proof of a Σ^0_2-sentence.

► BEKTUR BAIZHANOV, *Expansion of models of stable and weakly o-minimal theories*.
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The report is devoted to questions of expansions by new relations of models of subclasses of the class of dependent theories.

For models of weakly o-minimal theory there was obtained a condition guaranteeing that the expansion by all convex unary predicates implies definability of all n-types over the expanded model.

There were obtained necessary conditions on stable theories, which provides indiscernibility of set in a new language obtained by an expansion of a model by naming an infinite indiscernible set.

We suggest a notion of a stable up to a formula theory, which is a generalization of the notions of stable and o-minimal theories. In particular, all linear orderings are superstable up to linear order. It is proved, that stable up to a formula theories are dependent.

► JOHN T. BALDWIN, *Categoricity transfer in first order and AEC*.
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Over 40 years ago, Morley proved that a first order theory which is categorical (has only one model) in one uncountable cardinality is categorical in all uncountable cardinalities. We will discuss generalizations of Morley's theorem to the context of infinitary logics and abstract elementary classes. Although the first order analysis takes place in ZFC, some aspects of the infinitary theory require extensions of set theory. We will consider how recent refinements of these arguments shed light on the first order case.

► ROD DOWNEY, *Solovay functions, triviality and traceability*.
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This talk concerns part of the recent evolving programme devoted to understanding notions of low computational complexity and their relationship with low levels of algorithmic randomness. For the present talk I will look at work with Bienvenu and results by Merkle on Solovay functions which are "good" computable upper bounds for prefix-free complexity and well as related results on bounds of traceability if time permits.

► ILIJAS FARAH, *Nonseparable UHF algebras.*
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Uniformly HyperFinite (UHF) algebras are those C^* algebras in which every finite subset is 'near' a finite-dimensional full matrix subalgebra. This can be formalized in three different ways, all three being equivalent in the separable unital case. Separable UHF algebras were classified in the 1960s by Glimm and Dixmier. Dixmier asked whether three definitions are equivalent in the nonseparable case. I will give a complete answer to this question and some related applications. Then I will state some even more basic questions that we could not answer.

This is a joint work with Takeshi Katsura.

► RENLING JIN, *Plünnecke's inequality for various densities.*
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Let P be the set of all prime numbers and A be any infinite set of natural numbers. How much does the "size" of the set $A + P$ grow relative to the "size" of A? There are various definition of densities for measuring the "size" of an infinite set of natural numbers. Which density should be the right one in the question above?

In 1970, Plünnecke proved that if B is a (Shnirel'man) basis of order h, then the Shnirel'man density of $A + B$ is at least the Shnirel'man density of A to the power $1 - \frac{1}{h}$ for any $A \subseteq \mathbb{N}$. Plünnecke's inequality significantly improved an earlier result of Erdös–Landau. Unfortunately, P is not a (Shnirel'man) basis.

In this talk we show whether Plünnecke's inequality is true when Shnirel'man density is replaced by other densities such as lower asymptotic density, upper asymptotic density, and upper Banach density. We will also point out which density should be used when the set B is P and how dense $A + P$ is relative to that density of A.

The methods from nonstandard analysis should have advantages when dealing with asymptotic arguments. Density problems in additive/combinatorial number theory are ideal testing cases for this observation. We will demonstrate in an elementary level how to obtain a "Buy-One-Get-One-Free" scheme using nonstandard methods. This demonstration should give hints for the proofs of the main results being presented in the talk.

► ISKANDER SH. KALIMULLIN, *Algorithmic reducibilities of countable algebraic structures.*
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The talk will be devoted to the uniform and non-uniform reducibilities of mass problems of presentability of countable algebraic structures. The *uniform* (*strong*) reducibility of a structure $\mathfrak{A}$ to a structure $\mathfrak{B}$ holds, if there is a universal algorithmic procedure of generating a presentation of the structure $\mathfrak{A}$ given any presentation of the structure $\mathfrak{B}$. The *non-uniform* (*weak*) reducibility of a structure $\mathfrak{A}$ to a structure $\mathfrak{B}$ happens, if every presentation of the structure $\mathfrak{B}$ computes (in the Turing sense) some presentation of the structure $\mathfrak{A}$. Both reducibilities are natural generalizations of the Turing reducibility and of the enumeration reducibility.

The weak reducibility of countable structures is determined uniquely by the degree spectra of these structures. The *degree spectrum* of a countable structure is the collection of Turing degrees of its presentations. Slaman [4] and Wehner [5] constructed structures whose degree spectrum consists precisely of the noncomputable degrees. The following more general result holds.

THEOREM. [1, 2] *If a degree* $\mathbf{c}$ *is low or c.e. then there is a structure whose degree structure consists precisely of all degrees which are not* $\mathbf{c}$*-computable.*

It is proved that this statement can not be expanded to arbitrary degree below $\mathbf{0}''$ (see [3]). The applications of the theorem for the upper semilattices $\mathbf{D}_s$ and $\mathbf{D}_w$ of degrees of algebraic structures relative to the strong and to the weak reducibility, respectively, are listed below.

1. $\mathbf{D}_s$ and $\mathbf{D}_w$ are not lattices;
2. there are increasing sequences of degrees in $\mathbf{D}_s$ and $\mathbf{D}_w$ which have the least upper bound (in comparison with usual degree semilattices); moreover, there is a sequence of algebraic structures with increasing algorithmic complexity, such that the problem of simultaneous presentation of all its structures is equivalent to the problem of presentation of some other structure.
3. every countable distributive lattice is embeddable into $\mathbf{D}_w$; in particular, there is a nontrivial example of structures $\mathfrak{A}$, $\mathfrak{B}$, $\mathfrak{C}$, such that the problem of presentation of the structure $\mathfrak{C}$ is non-uniformly equivalent to the problem of constructing a structure which will be isomorphic either to $\mathfrak{A}$, or to $\mathfrak{B}$.

Furthermore, we will discuss about differences between strong and weak reducibilities, and also their relationships with the Σ-definability of structures in admissible sets.

[1] I. SH. KALIMULLIN, *Spectra of degrees of some structures*, ***Algebra and Logic***, vol. 46 (2007), pp. 399–408.

[2] ———, *Almost computably enumerable families of sets*, ***Sbornik. Mathematics***, vol. 199 (2008), 1451–1458.

[3] ———, *Restrictions on degree spectra of algebraic structures*, ***Siberian Mathematical Journal***, vol. 49 (2008), pp. 1034–1043.

[4] T. A. SLAMAN, *Relative to any nonrecursive set*, ***Proceedings of the American Mathematical Society***, vol. 126 (1998), pp. 2117–2122.

[5] S. WEHNER, *Enumerations, countable structures, and Turing degrees*, ***Proceedings of the American Mathematical Society***, vol. 126 (1998), pp. 2131–2139.

► PETER KOELLNER, *On reflection principles*.
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Gödel initiated the program of finding and justifying axioms that effect a significant reduction in incompleteness and he drew a fundamental distinction between intrinsic and extrinsic justifications. Reflection principles are the most promising candidates for new axioms that are intrinsically justified. Taking as our starting point Tait's work on general reflection principles, we will discuss a series of limitative results concerning this approach. These results collectively show that general reflection principles are either weak (in that they are consistent relative to the Erdös cardinal $\kappa(\omega)$) or inconsistent.

► MANUEL LERMAN, *Cappable CEA sets and Ramsey's theorem*.
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We begin a search for degree-theoretic properties that might be used to separate Ramsey's Theorem for pairs from its stable version in the reverse mathematical sense. We define a degree $\mathbf{b}$ to be *c-cappable* if there is a c.e. degree $\mathbf{a}$ such that $\mathbf{a}$ and $\mathbf{b}$ form a minimal pair. We obtain the following results.

THEOREM 1. *There is a c.e. degree* **a** *and a* 2*-CEA c-cappable degree* **b** *such that* **a** *and* **b** *form a minimal pair and whose join is* $\mathbf{0}'$.

Thus the 2*-cappable CEA degrees do not form an ideal which omits* $\mathbf{0}'$.

THEOREM 2. *There is a computable stable coloring of pairs of integers that does not have a homogeneous set computable from a c-cappable* 2*-CEA degree.*

This work is joint with Asher Kach and Reed Solomon.

► MENACHEM MAGIDOR, *Some reflections on compactness and incompactness properties of singular cardinals*.
Einstein Institute of Mathematics, The Hebrew University of Jerusalem, Jerusalem, 91904, Israel.

► MICHAEL RATHJEN, *Infinitary proof theory and the extraction of conservation results*.
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Although Hilbert envisioned the methods of proof theory to be completely finitistic in character, the infusion of infinitary concepts into the area started as early as the 1920s and flourished in the 1950s when proof theory began to employ infinitary methods more frankly with the use of infinitary rules of inference (such as the omega rule). Proof theory moved on to make use of prima facie uncountably long rules of inference and collapsing techniques. These infinitely long derivations have been applied to treat various formal systems for parts of analysis and set theory.

In the talk I will take up the following question: Why (and how) does infinitary proof theory yield finitistic (partial) conservativity results? A plethora of conservation results have been obtained in this way, asserting that a theory T is conservative over a theory S for a certain complexity class of formulas. The conservative extension statement itself is a Π^0_2 sentence. An interesting question is whether this Π^0_2 sentence has a "reasonable" Skolem function.

► GERALD E. SACKS, *Models of long sentences I*.
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Issues that arise in the construction of models of uncountable theories in infinitary logic.

► STEPHEN G. SIMPSON, *Computable symbolic dynamics*.
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Let G be a computable group, and let A be a finite alphabet. By a *G-subshift* we mean a nonempty subset of A^G which is topologically closed and closed under the action of G. It can be shown that any G-subshift X is defined by a countable set E of excluded finite configurations. If E is finite, we say that X is *of finite type*. If E is computable, we say that X is *of computable type*. It can be shown that most or all G-subshifts which arise in practice are of computable type. Let X be of computable type, and let $P(X)$ be the problem of finding a point of X. If X is *minimal* (i.e., every orbit is dense) and of computable type, then $P(X)$ is algorithmically solvable (a result of Michael Hochman). Let us say that X is *d-dimensional* if $G = \mathbb{Z}^d$. If X is 1-dimensional and of computable type, then $P(X)$ can be of any desired degree of unsolvability (a result of Joseph Miller). If X is 2-dimensional and of finite type, then $P(X)$ can be of any desired degree of unsolvability (my result). The 1-dimensional subshifts of computable type are precisely those which can be obtained as projections of 2-dimensional subshifts of finite type (a result of Alexander Shen).

► THEODORE A. SLAMAN, *Degree invariant functions*.
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We will discuss Martin's Conjecture for functions which are invariant with respect to Turing degree and Kechris's question of whether Turing equivalence is universal among countable Borel equivalence relations. In a result jointly obtained with Montalbán and Reimann, we will give a restriction on the possible ways by which Turing equivalence could be universal.

► FRANK STEPHAN, *An overview of automatic structures and learning*.
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Automatic structures are structures where not only the sets involved but also the relations involved can be recognized by a finite automaton which reads in the case of relations all inputs at the same speed symbol by symbol. Therefore automatic structures can be used to describe the hypothesis space as well as the learner in inductive inference. In the first part it is investigated what can be said about learning in such a context and when such a learner can be automatic. In the second part of the talk, an overview is given on how the setting of omega-automatic structures can be used to formulate learnability of uncountable classes of sets of words where then the index of such each such set has to be an omegaword and to which extent the results in that setting are parallel to the standard work on countable classes of sets of words.

This talk is based on joint work with Sanjay Jain, Luo Qinglong and Pavel Semukhin.

► W. HUGH WOODIN, *Determinacy in higher order number theory*.
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It was proved nearly 20 years ago that the theories, ZFC + "There is a Woodin cardinal", and ZFC + "All ordinal definable sets of reals are determined", are equiconsistent. Replacing ZFC by weaker fragments leads to much more subtle problems. By a more recent result, the theory KM + "Ord is a Woodin cardinal" is equiconsistent with PA_3 + "All definable sets of reals are determined". Here PA_3 is third order number theory and KM is Kelley–Morse set theory. We also discuss the situation for second order number theory.

Abstracts of contributed talks

► RYOTA AKIYOSHI AND GRIGORI MINTS, *An ordinal-free proof of the cut-elimination theorem for Π^1_1-CA with ω-rule*.
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We present an ordinal-free proof of the cut-elimination theorem for impredicative systems using Buchholz's Ω-rule. In this talk, we present in detail the proof for a subsystem BI_1 as an example.

One cut-elimination step performed on a derivation d in BI_1 corresponds to passing to a subderivation of $g(d)$ having smaller height where g is an embedding function from BI_1 to BI_1^{Ω}, which contains Buchholz's Ω-rule. Thus the cut-elimination theorem for BI_1 is proved just by transfinite induction on the size of $g(d)$.

We outline extension to the full Π^1_1-CA.

► BARBARA F. CSIMA, ROD DOWNEY AND KENG MENG (SELWYN) NG, *Limits on jump inversion for strong reducibilities*.
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The study of strong reducibilities has been a major part of computability for a long time. As is well known, tabular reducibilies such as weak truth table (wtt-) and truth table (tt-) reducibilities place restrictions on oracle access. These reducibilities arise very naturally when we consider reducibilities coming from reductions in mathematical structures. In recent times, truth table reducibility has become a central area of interest as it has been shown to be a natural reducibility to study in *algorithmic randomness*.

For Turing reducibility, we know a lot about how the jump operator behaves. The classical "jump inversion" theorems are that of Friedberg's, Shoenfield's and Sacks' which basically say that the jump operator (and with different restrictions on the domain) is onto. Recent work by Anderson analyzing an old result of Mohrherr renewed interest in the variations of these theorems, particularly their connection with the strong reducibilities.

We prove that the analogs of Shoenfield's and Sacks' jump inversion results fail when considering tt- and wtt-reducibilities, and in fact they fail in more or less the strongest way that they can. One of our main results show that for any computable sequence of Δ^0_2 sets $\{V_e\}_{e\in\mathbb{N}}$, there exists a Δ^0_2 set $S \geq_{tt} \emptyset'$ such that for every e, $V_e' \not\equiv_{wtt} S$.

► ADAM R. DAY, *The computational power of random strings*.
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There are two fundamental computably enumerable sets associated with any Kolmogorov complexity measure. These are the set of non-random strings and the overgraph.

In this talk we will investigate the computational power of these sets. We will review work done by Kummer, Muchnik and Positselsky, and Allender and co-authors who have examined the computational power of these sets for plain and prefix-free Kolmogorov complexity.

Then we will present some new results in this area. First, that the overgraph of any optimal monotone machine, or any optimal process machine, is tt-complete. The monotone results hold for both descriptional complexity K_m and KM, the complexity measure derived from algorithmic probability. This provides a negative answer to a question of Muchnik and Positselsky as to whether there exists an optimal monotone machine whose overgraph is not tt-complete.

Secondly, we will draw a distinction between two definitions of process machines that exist in the literature. For one class of process machines, designated strict process machines, it is shown that there is a universal machine whose set of nonrandom strings is not tt-complete.

► JOHANNA N. Y. FRANKLIN, *Kurtz randomness, Schnorr randomness, and genericity*.
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Kurtz randomness can be considered to be a weak genericity notion as well as a weak randomness notion. Both the Schnorr random reals and weakly 1-generic reals are subclasses of the Kurtz random reals, and therefore so are the n-generic reals for every n. No Schnorr random real can be weakly 1-generic, but these notions are still compatible to some extent in the contexts of various degree structures. I will describe the extent to which genericity and Schnorr randomness are compatible in the Turing, weak truth table, and truth table degrees.

► JOHN GOODRICK, *Type amalgamation and generalized imaginary sorts*.
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Type amalgamation properties are about when certain kinds of finite systems of types are consistent. In stable or simple theories, triples of complete types $p_{12}(x_1, x_2)$, $p_{23}(x_2, x_3)$, and $p_{13}(x_1, x_3)$ over a model which satisfy natural coherence and independence conditions can always be amalgamated—this is called the 3-existence property over models. Similarly, the n-existence property is about amalgamating systems of types indexed by proper subsets of $\{1, \dots, n\}$.

Hrushovski recently characterized which stable theories have the 4-existence property in terms of definable groupoids in the theory. In joint work with Alexei Kolesnikov, we found some new characterizations of 4-existence, for instance that it is equivalent to certain type-definable groupoids being definably retractable, and that 4-existence can be detected by looking just at the definable abelian groupoids. We are hopeful that these methods can be extended to characterize n-existence.

► JIANYONG HONG AND SHUGUO ZHANG, *The algebraic sum of special sets of reals*.
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In this talk, we will present the following results on special subsets of reals.

1. It is consistent with ZFC that for any perfect measure zero set $D \subseteq 2^\omega$ there are $X \in SMZ$, $Y \in \mathcal{UM}(X \in UMZ, Y \in SFC$, respectively) satisfying $X + Y \supseteq D$. This gives an answer to a question of Andrzej Nowik and Tomasz Weiss.

2. $non(\mathcal{UM}) = non(\mathcal{M})$ and $add(\mathcal{UM}) \geq add(\mathcal{M})$.

3. Strengthening a result of Nowik, we show the algebraic sum of two towers are universally meager set, i.e., $X = \{x_\alpha : \alpha < \mathfrak{t}\}$, $Y = \{y_\alpha : \alpha < \mathfrak{t}\}$ are towers in $[\omega]^\omega$, then the algebraic sum of X and Y is a universally meager set, i.e., $X + Y \in \mathcal{UM}$

4. Every meager additive set in 2^ω is a set of perfect meager in the transitive sense, i.e., $\mathcal{M}^\star \subseteq AFC'$, this strengthens a result of Kysiak, Nowik and Weiss.

► JOHN KRUEGER, *On the Weak Reflection Principle*.
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The *Weak Reflection Principle* for ω_2 is the statement that for every stationary set $S \subseteq P_{\omega_1}(\omega_2)$, there is an uncountable ordinal α in ω_2 such that $S \cap P_{\omega_1}(\alpha)$ is stationary in $P_{\omega_1}(\alpha)$. The *Reflection Principle* for ω_2 is the statement that for every stationary set $S \subseteq P_{\omega_1}(\omega_2)$, there is an ordinal α in ω_2 with cofinality ω_1 such that $S \cap P_{\omega_1}(\alpha)$ is stationary in $P_{\omega_1}(\alpha)$. A long outstanding problem in set theory has been the question whether the Weak Reflection Principle for ω_2 implies the Reflection Principle for ω_2. In this talk I will discuss my recent solution to this problem.

► MASAHIRO KUMABE AND TOSHIO SUZUKI, *Computable Dowd-type generic oracles*.
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In [2], we study the following property $(*)$ of an oracle X. $(*)$ "For every positive integer r, X is r-generic in the sense of Dowd [1]" (that is, for each r, the forcing complexity of the r-query tautologies with respect to X is bounded by a polynomial; this property is different from r-genericity of arithmetical forcing). In [2], we show that if X is Schnorr random then X has the property $(*)$, and that the property $(*)$ is conserved through a certain type of p-time bounded-truth-table reduction. In the current talk, we show the followings: (1) There exists a primitive recursive oracle X that has the property $(*)$; (2) Every Turing degree contains an oracle X that has the property $(*)$. These results are extensions of results in [3] about 1-genericity in the sense of Dowd. (2) is an affirmative solution to Problem 4 in [3].

[1] M. Dowd, *Generic oracles, uniform machines, and codes*, ***Information and Computation***, vol. 96 (1992), pp. 65–76.

[2] M. Kumabe and T. Suzuki, *Weak randomness, genericity and Boolean decision trees*, a talk at ***The 10th Asian Logic Conference***, Kobe University, Kobe, Japan (2008).

[3] T. Suzuki, *Degrees of Dowd-type generic oracles*, ***Information and Computation***, vol. 176 (2002), pp. 66–87.

► JIANG LIU, SHENLING WANG AND GUOHUA WU, *Infima of d.r.e. degrees*.
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Lachlan observed that the infimum of two r.e. degrees considered in the r.e. degrees coincides with the one considered in the Δ^0_2 degrees. It is not true anymore for the d.r.e. degrees. Kaddah proved that there are d.r.e. degrees $\mathbf{a}, \mathbf{b}, \mathbf{c}$ and a 3-r.e. degree $\mathbf{x}$ such that $\mathbf{a}$ is the infimum of $\mathbf{b}, \mathbf{c}$ in the d.r.e. degrees, but not in the 3-r.e. degrees—so not in Δ^0_2-degrees, as $\mathbf{a} < \mathbf{x} < \mathbf{b}, \mathbf{c}$. In this talk, we extend Kaddah's result by showing that such a structural difference occurs densely in the r.e. degrees.

► RYSZARD MIREK, *The systems of relevance logic. Weak systems*.
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The system R, or more precisely the pure implicational fragment $R_{\rightarrow}$, is considered by the relevance logicians as most important and delightful. First of all, $R_{\rightarrow}$ is the oldest one. It has been formulated independently by Moh Shaw-Kwei in 1950 and A. Church in 1951. Church calls his system the "weak positive implicational propositional calculus". The another central system of relevance logic has been the logic E of entailment that was supposed to capture strict relevant implication. C. I. Lewis added a new connective to classical logic, it means the strict implication, to create the modal systems in order to avoid the paradoxes of material implication. The next system of relevance logic that is called RM or R-mingle. RM is the axiomatic extension of R by the mingle axiom $\alpha \rightarrow (\alpha \rightarrow \alpha)$ (MA). The question is whether adding (MA) to $R_{\rightarrow}$ yields the pure implicational fragment $RM_{\rightarrow}$ of the system? The answer is negative—instead of $RM_{\rightarrow}$ one obtains $RMO_{\rightarrow}$. The former system may be described by independent and complete set of axioms. It means that RM is not a conservative extension of $RMO_{\rightarrow}$. As concerns the weak systems there are at least two approaches to the problem. First of all, it is possible to restrict a validity of some theorems as in the logic S of Martin and Meyer in which we have just two axioms or the Brady's content semantics DJ^d in which we have a weaker form of transitivity. In another approach we can investigate even weaker logics which have no theorems and are characterized only by rules of deducibility as in the Gabbay's systems $\vdash_0$ and $\vdash_1$ or Font and Rodriguez the deductive system WR.

► ANDRÉ NIES, *Ideals in the c.e. Turing degrees*.
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The interplay of computability and randomness has led to several natural ideals in the computably enumerable degrees such as the K-trivial or the strongly jump traceable degrees. We show that every proper Σ^0_4 ideal in the c.e. Turing degrees has an incomplete upper bound. It follows that there is no Σ^0_4 prime ideal in the c.e. Turing degrees. This answers a question of Calhoun. Every proper Σ^0_3 ideal in the c.e. Turing degrees has a low_2 upper bound. Furthermore, the partial order of Σ^0_3 ideals under inclusion is dense.

This is joint work with George Barmpalias.

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From the negative solution of Hilbert's tenth problem, we have the following results: For any number $a \in N$, the decision problems of determining for an arbitrary $f(x_1, \dots, x_n) \in Z[x_1, \dots, x_n]$ whether or not $\exists x_1 \dots \exists x_n\, |f(x_1, \dots, x_n)| \leq a$ is true in N (or Z) and whether or not $\exists x_1 \dots \exists x_n\, \forall y\, |f(x_1, \dots, x_n) - y| > a$ is true in N are undecidable, if the number of variables n is sufficiently large. In this paper, some similar problems are shown to be decidable. We also give the computational complexities of these decidable cases.

In particular, we show the following:

1. The decision problem of determining for an arbitrary $f(x, y) \in Z[x, y]$ and an arbitrary $a \in N$ whether or not $\forall x\, \exists y\, |f(x, y)| \geq a$ is true in N (or Z) is in P.
2. The decision problem of determining for an arbitrary $f(x, y) \in Z[x, y]$ and an arbitrary $a \in N$ whether or not $\exists x\, \forall y\, |f(x, y)| > a$ is true in N is NP-complete.
3. The decision problem of determining for an arbitrary $f(x, y) \in Z[x, y]$ whether or not $\forall z\, \exists x\, \forall y\, |f(x, y)| \geq z$ is true in N is NP-complete.
4. The decision problem of determining for an arbitrary $f(x_1, \dots, x_n, y) \in Z[x_1, \dots, x_n, y]$ with $n > 0$ and an arbitrary $a \in N$ whether or not $\exists x_1 \dots \exists x_n\, \forall y\, |f(x_1, \dots, x_n, y)| > a$ is true in Z is NP-complete.
5. The decision problem of determining for an arbitrary $f(x_1, \dots, x_n, y) \in Z[x_1, \dots, x_n, y]$ whether or not $\forall z\, \exists x_1 \dots \exists x_n\, \forall y\, |f(x_1, \dots, x_n, y)| \geq z$ is true in Z is NP-complete.

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Downey pointed out in [1] that his construction of the diamond lattice can be modified to show that the 1-n-1 lattices can be embedded into the d.c.e. degrees preserving 0 and 1. However, no particular detail is provided so far, and we believe that a standard tracing argument should be used in the modification to ensure the consistency of the splitting of $\mathbf{0}'$ and the minimal pair argument, which makes the construction complicated. In this talk, we will present another construction of such embeddings, where the splitting of $\mathbf{0}'$ and the minimal pair argument are separated, and hence avoid the tracing successfully. This provides a simpler construction needed for the embedding.

[1] R. Downey, *D.r.e. degrees and the nondiamond theorem*, ***Bulletin of the London Mathematical Society***, vol. 21 (1989), pp. 1–10.

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In this research, we do non-standard analysis in non-standard second order arithmetic. We first introduce some systems of non-standard second order arithmetic in which one can conveniently carry out non-standard analysis (see [2]). Within second order arithmetic, we can use some techniques of non-standard analysis by model theoretic arguments (see, e.g., [1]). Within our new systems, we can do a wider range of non-standard analysis using several non-standard axioms. Then, our next aim is to do Reverse Mathematics for non-standard analysis. Although standard theorems never imply non-standard axioms, we can find the non-standard counterparts of standard theorems. We can show that some of the non-standard counterparts of standard theorems require non-standard axioms. Moreover, we can apply these arguments of non-standard analysis to standard Reverse Mathematics within second order arithmetic by some conservation results. For example, we can show that the Riemann mapping theorem for Jordan region is provable within WKL_0 by combining a piecewise linear version of the Riemann mapping theorem together with some non-standard techniques.

[1] KAZUYUKI TANAKA, *Non-standard analysis in* WKL_0, ***Mathematical Logic Quarterly***, vol. 43 (1997), no. 3, pp. 396–400.

[2] KEITA YOKOYAMA, *Formalizing non-standard arguments in second order arithmetic*, preprint.

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I shall briefly survey some recent results in higher randomness and present some interesting questions.