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# 2013 EUROPEAN SUMMER MEETING OF THE ASSOCIATION FOR SYMBOLIC LOGIC

## LOGIC COLLOQUIUM '13

**Evora, Portugal**
**July 22–27, 2013**

Logic Colloquium '13, the 2013 European Summer Meeting of the Association for Symbolic Logic, was hosted by the University of Evora, Portugal, from July 22 to July 27, 2013. The University of Evora is spread all over the historic city center of Evora, one of Portugal's most beautifully preserved medieval towns, which was declared World Heritage by the UNESCO in 1986. The lectures were held at the main building of the university, Colégio Espirito Santo, which dates from 1559 and contains 10 spacious classrooms.

Major funding for the conference was provided by: the Association for Symbolic Logic (ASL); Fundação para a Ciência e a Tecnologia, Portugal; Center for Applied and Fundamental Mathematics (CMAF), University of Lisbon; the Center for Research and Development in Mathematics and Applications (CIDMA), University of Aveiro; Center for Informatics and Systems (CISUC), University of Coimbra; Research Center in Mathematics and Applications (CIMA-UE), University of Evora; Center for Mathematics, Artificial Intelligence and Computer Science Laboratory, University of Porto; Center for Mathematical Analysis, Geometry, and Dynamical Systems, Technical University of Lisbon; Portuguese Society of Mathematics (SPM); International Center for Mathematics, Portugal; and, the Kurt Gödel Society.

The success of the meeting was due largely to the hard work of the Local Organizing Committee under the leadership of its Chair, Mário Edmundo (Univ. Aberta and CMAF). The other members of the committee were Sandra Alves (Univ. Porto and LIACC), Imme van den Berg (Univ. Evora and CIMA), Fernando Ferreira (Univ. Lisbon and CMAF), Daniel Graça (Univ. Algarve and SQIG Instituto de Telecomunicações), Marcello Mamino (CMAF), Manuel Martins (Univ. Aveiro and CIDMA), Luis Pinto (Univ. Minho and CMAT), Pedro Quaresma (Univ. Coimbra and CISUC), and João Rasga (IST–UTL and SQIG Instituto de Telecomunicações).

The Program Committee consisted of Matthias Baaz (Vienna), Michael Benedikt (Oxford), Mário Edmundo (Lisbon), Sakae Fuchino (Kobe), Valentina Harizanov (George Washington University), Paolo Mancosu (Berkeley), Katrin Tent (Muenster), and Boban Velickovic (Paris, Chair).

The main conference topics were Computability Theory and Logic for Computer Science; Foundations of Mathematics and Philosophy of Logic; Model Theory; Proof Theory and Constructive Mathematics; and Set Theory. The program included two tutorial courses, eleven invited plenary lectures, and twenty invited lectures in five special sessions. There were seventy eight contributed talks and 168 participants. Twenty two students and recent Ph.D's were awarded ASL travel grants.

The following tutorial courses were given:

Abderezak Ould Houcine (University of Lyon), *Introduction to elementary properties of free groups*.

Luke Ong (Oxford University), *Higher-order model checking*.


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The following invited plenary lectures were presented:

Johan van Benthem (University of Amsterdam), *Logical foundations of games and interaction.*

Mikołaj Bojańczyk (Warsaw University), *Computation in sets with atoms.*

Jorg Brendle (Kobe University), *Forcing theory and the size of the continuum.*

Rosalie Iemhoff (Utrecht University), *On rules.*

François Loeser (Université Pierre et Marie Curie), *From universal dendrites to stably dominated types: the topology of nonarchimedean spaces.*

Steffen Lempp (University of Wisconsin-Madison), *A strong minimal pair of computably enumerable Turing degrees.*

Maryanthe Malliaris (University of Chicago), *Cofinality spectrum problems.*

Andrey Morozov (Sobolev Inst. of Math. and Novosibirski State University), *Computable model theory over the reals: an approach based on admissible sets.*

Jean-Philippe Rolin (Universitè de Bourgogne – Dijon), *Weierstrass preparation in quasianalytic local rings.*

Asger Törnquist (University of Copenhagen), *A descriptive set-theoretic view of classification problems in operator algebras.*

Vladimir Voevodsky (Institute for Advanced Study), *Univalent Foundations of Mathematics.*

The proceedings of Logic Colloquium '13 will be published in a special issue of the *Annals of Pure and Applied Logic*.

More information about the meeting can be found at the conference webpage, `http://ptmat.fc.ul.pt/LC2013/`.

Abstracts of invited and contributed talks given in person or by title by members of the Association follow.

For the Program Committee
BOBAN VELICKOVIC

### Abstracts of invited tutorials

► ABDEREZAK OULD HOUCINE, *Introduction to elementary properties of free groups.*
Institut Camille Jordan, Bâtiment Braconnier, Université Claude Bernard Lyon 1, 43 boulevard du 11 novembre 1918, 69622 Villeurbanne cedex, France.
*E-mail*: `ould@math.univ-lyon1.fr`.

We give in this tutorial an overview of some recent developments on the elementary theory of nonabelian free groups. We introduce the basic tools as limit groups, actions on trees, asymptotic cones, JSJ-decompositions, and we explain how they can be used in the study of the elementary theory. We focus in particular on homogeneity, algebraic closure, and ampleness.

[1] A. OULD HOUCINE. *Homogeneity and prime models in trosion-free hyperbolic groups.* ***Confluentes Mathematici***, vol. 3 (2011), no. 1, pp. 121–155.

[2] A. OULD HOUCINE and K. TENT. *Ampleness in the free group.* `ArXiv`, 2012.

[3] A. OULD HOUCINE and D. VALLINO. *Algebraic and definable closure in free groups.* `ArXiv`, 2011.

► LUKE ONG, *Higher-order model checking.*
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by the Deutsche Vereinigung für Mathematische Logik und für Grundlagenforschung der Exakten Wissenschaften (DVMLG).

► WILLIAM GUNTHER AND RICHARD STATMAN, *Lambda-delta-definability and-Henkin's theorem.*
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The $\lambda\delta$-calculus is the $\lambda$-calculus augmented with a discriminator distinguishing terms. We consider the simply typed $\lambda$-calculus over one atomic type variable augmented with a discriminator, description operator, and an existential quantifier all of lowest type. First, we provide a proof of a folklore result which says that a function in the full type structure over $[n]$ is $\lambda\delta$-definable from the description operator and existential quantifier if and only if it is symmetric, i.e., fixed under an action by permutations of $n$ elements. This proof uses only elementary facts from algebra and a way to reduce functions to functions of lowest type via a theorem of Henkin. Then we prove a necessary and sufficient condition for a function on $[n]$ to be $\lambda\delta$-definable without the description operator or existential quantifier, which requires a stronger notion of symmetry.

► STEFAN HETZL, *Proofs and grammars.*
Institute of Discrete Mathematics and Geometry, Vienna University of Technology, Wiedner Hauptstraße 8–10, 1040 Vienna, Austria.
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Proof theory models the use of lemmas in mathematical proofs by the inference rule of cut. In addition to rendering a proof more readable the use of cuts may also lead to a significantly shorter proof.

Formal language theory is an important area in theoretical computer science. Mechanisms for specifying formal languages such as grammars and automata play a central role in a variety of applications.

In this talk I will speak about recent results that connect proof theory to formal language theory by characterizing the compression power of classes of cut-formulas by classes of formal grammars.

This connection is established for proofs in classical first-order logic by relying on Herbrand's theorem and thus identifying a cut-free proof with a finite tree language and the proof with cut with a grammar describing this language. The computation of the language of the grammar then corresponds to cut-elimination.

► ASSYLBEK ISSAKHOV, *Some computable numberings of the families of total functions in the arithmetical hierarchy.*
Department of Mechanics and Mathematics, Al-Farabi Kazakh National University, 71 Al-Farabi Ave., Almaty 050038, Kazakhstan.
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A numbering $\nu : \omega \mapsto \mathcal{F}$ of a family of unary computable functions is called computable if the binary function $\nu(n)(x)$ is computable, [3]. A Friedberg numbering of a family is just a computable one-to-one numbering. It is well known that the Rogers semilattice of a computable family $\mathcal{F}$ either consists of one element or is infinite, [3]; and that, in the nontrivial case, it is never a lattice and has no maximal elements; and contains either one or infinitely many minimal elements, [4].

We generalize the notion of computable numbering for the families of functions in the arithmetical hierarchy following [1]. Let $\mathcal{F}$ be a family of total unary functions from $\Sigma^0_{n+1}$, $n \in \omega$. A numbering $\nu : \omega \mapsto \mathcal{F}$ is called $\Sigma^0_{n+1}$-computable if the binary function $\nu(n)(x)$ is computable relative to the oracle $\emptyset^{(n)}$ [1].

THEOREM 1. *Let $\mathcal{F} \subseteq \Sigma^0_{n+2}$ be an infinite $\Sigma^0_{n+2}$-computable family of total functions. Then $\mathcal{F}$ has infinitely many pairwise nonequivalent Friedberg numberings.*

THEOREM 2. *There are a family $\mathcal{F}$ and $\Sigma^0_{n+2}$-computable numbering $\alpha$ of the family $\mathcal{F}$ such that no Friedberg numbering of $\mathcal{F}$ is reducible to $\alpha$.*

This is a solution to Question 2, [2]:

THEOREM 3. *If $\mathcal{F}$ contain at least two functions, then $\mathcal{F}$ has no principal $\Sigma^0_{n+2}$-computable numbering.*

[1] S. A. BADAEV and S. S. GONCHAROV. *Rogers semilattices of families of arithmetic sets.* ***Algebra and Logic***, vol. 40 (2001), no. 5, pp. 283–291.

[2] ———. *The theory of numberings: Open problems.* ***Contemporary Mathematics***(Peter A. Cholak, Steffen Lempp, Manuel Lerman and Richard A. Shore, editors), University of Colorado, Boulder, vol. 257, American Mathematical Society, 2000, pp. 23–38.

[3] YU. L. ERSHOV. ***Theory of numberings*** (in Russian). Nauka, Moscow, 1977 .

[4] S. S. MARCHENKOV. *The computable enumerations of families of general recursive functions.* ***Algebra and Logic***, vol. 11 (1972), no. 5, pp. 326–336.

► AKITOSHI KAWAMURA, FLORIAN STEINBERG, AND MARTIN ZIEGLER, *Complexity of Laplace's and Poisson's Equation compared to ordinary integration.*
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The last years have seen an increasing interest in classifying (existence claims in) classical mathematical theorems according to their strength: in terms of the underlying logical systems sufficient and necessary for their proof (see e.g., the works of S. SIMPSON, U. KOHLENBACH, H. ISHIHARA) as well as in terms of their computational power (V. BRATTKA), that is, (e.g., WEIHRAUCH-)degrees of computability. We pursue the latter under the refined view of asymptotic computational worst-case complexity (M. BRAVERMAN & S. A. COOK 2006).

H. FRIEDMAN and KER-I KO (1982) have shown basic operations in numerics to be surprisingly hard and related to one of the Millennium Problems: The maximum operator $C[0;1] \ni f \mapsto \big(x \mapsto \max\{f(t)\colon 0 \le t \le x\}\big) \in C[0;1]$ maps polynomial-time ($\mathcal{P}$) computable functions $f$ to ones essentially belonging to $\mathcal{NP}$—and that is in general optimal, even for smooth arguments $f \in C^\infty[0;1]$. Similarly, the complexity of the indefinite integral operator $C[0;1] \ni f \mapsto \big(x \mapsto \int_0^x f(t)\,dt\big)$ is related to the question of $\mathcal{P}$ versus $\#\mathcal{P}$. The solution $u$ to the ordinary differential equation $u'(t) = f\big(t, u(t)\big)$ with polynomial-time computable $C^1$ right-hand side $f\colon [0;1]\times[-1;1] \to [-1;1]$ and initial condition $u(0) = 0$ can even be as complex as PSPACE (KAWAMURA 2010ff).

The present work starts exploring analogous questions for simple elliptic partial differential equations with computable classical solutions (as opposed to the hyperbolic Wave equation: POUR-EL&RICHARDS 1981).

(1) $\Delta u = 0$ on $\Omega$, $\quad u = g$ on $\partial\Omega$

(2) $\Delta u = f$ on $\Omega$, $\quad u = 0$ on $\partial\Omega$

for fixed open domains $\Omega \subseteq [-1;1]^d$ and continuous/smooth $f\colon \overline{\Omega} \to \mathbb{R}$ and $g\colon \partial\Omega \to \mathbb{R}$. (Note that our uniform complexity theory requires $f$ to extend to $\partial\Omega$.)

Steinberg's travel to LC2013 was partly supported by the *Association for Symbolic Logic* (ASL) and by *Deutsche Vereinigung für Mathem. Logik und für Grundlagenforschung der Exakten Wissenschaften* (DVMLG).