International conference "Logical models of reasoning and computation" will take place at Steklov Mathematical Institute in Moscow, Russia, from 5.05.2008 to 8.05.2008. The conference will cover a variety of topics in theoretical and applied logic centered around the notions of proof and computation.

Program committee

S. Adian (chair), L. Beklemishev (vice-chair), M. Baaz (Vienna),
M. Parigot (Paris), A. Visser (Utrecht)

Conference location

Steklov Mathematical Institute, Gubkina 8, 119991 Moscow
Conference hall, 9-th floor, tel. (495)938-37-44.
E-mail: `LMRC08@mi.ras.ru`
Web-page: `http://lmrc08.mi.ras.ru`

Registration

Conference Hall, 9th floor, Monday, May 5, 10:00 am.

Sponsored by

Russian Academy of Sciences
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The Netherlands Organization for Scientific Research (NWO)
Kurt Gödel Society (Vienna)

PROGRAM

Monday, 05 May. Conference hall, 9-th floor.

9:00–10:25 Registration and Coffee

10:25–10:30 Opening

10:30–11:10 Albert Visser. *Consistency without coding.*

In our talk we discuss the question of coordinate-free representations of consistency statements of finitely axiomatized theories. We will explain the following facts:

1. Let $SEQ(A)$ be the result of adding a good theory of sequences to A. Then, $SEQ(A)$ is mutually interpretable with $Q + Cutfreecon(A)$, where Q is Robinson's Arithmetic and $Cutfreecon(A)$ is the statement expressing the cutfree consistency of A. We can replace cutfree consistency in this statement by tableaux consistency or by Herbrand consistency.

2. Let $PCS(A)$ be the result of adding sequences and classes to A, where the classes satisfy predicative comprehension. Then, $PCS(A)$ is mutually interpretable with $Q + Con(A)$, where $Con(A)$ is the statement expressing the consistency of A.

3. For P, P' in $\Pi 01$, we have $Q + P$ is mutually interpretable with $Q + P'$ iff $EA \vdash P \leftrightarrow P'$. Here EA is Elementary Arithmetic, aka $I\Delta 0$+Exp. It follows that, e.g., $SEQ(A)$ is mutually interpretable with $Q + P$ iff P is EA-provably equivalent to $Cutfreecon(A)$. Thus, we have coordinatefree characterizations of cutfree consistency and consistency modulo EA-provable equivalence. We discuss the possibility of extending these results to the infinitely axiomatized case. Tempore volente, we discuss the application of the ideas treated here to the determination of the strength of the Predicative Frege Hierarchy.

11:00–11:50 Lev Beklemishev. *Kripke models for GLP.*

A well-known polymodal provability logic *GLP* introduced by G. Japaridze is complete w.r.t. the arithmetical semantics where modalities correspond to reflection principles of restricted logical complexity in arithmetic. This system plays an important role in some applications of provability algebras in proof theory. However, an obstacle in the study of *GLP* is that it is incomplete w.r.t. any class of Kripke frames. We provide a complete Kripke semantics for *GLP*. First, we isolate a certain subsystem J of *GLP* that is sound and complete w.r.t. a nice class of finite frames. Second, appropriate models for *GLP* are defined as the limits of chains of finite expansions of models for J. The techniques involves unions of n-elementary chains and inverse limits of Kripke models. All the results are obtained by purely modal-logical methods formalizable in elementary arithmetic.

11:50–12:10 Coffee

12:10–12:50 Michael Moorgat. *Formulas-as-types for the Lambek-Grishin calculus.*

From a logical perspective, Lambek's syntactic calculus is a substructural logic obeying the intuitionistic single succedent formula restriction. As a result of this restriction, the Lambek calculus cannot adequately deal with discontinuous dependencies – a type of dependency which is pervasive in natural language syntax and semantics. The paper discusses a symmetric extension of the Lambek calculus based on work by V.N. Grishin. In the Lambek-Grishin calculus, the product and division operations are complemented by a dual family (sum and difference); the two families interact via structure-preserving distributivity laws. I present the Curry-Howard correspondence for the Lambek-Grishin calculus as a restriction and refinement of Curien & Herbelin's sequent version of Parigot's lambda-mu calculus. The connection with a Montague style interpretation is established via a *CPS* translation of the Lambek-Grishin proof terms. (Joint work with Raffaella Bernardi)

12:50–13:30 **Mati Pentus.** *An Efficient Characterization of Type Similarity for the Lambek-Grishin Calculus.*

We consider the Lambek-Grishin calculus, which extends the non-associative Lambek calculus by adding dual connectives and stipulating some of the axioms considered by V.N. Grishin in 1983. Two types of this calculus are called similar if and only if there exists a type that generalizes them both. We characterize this relation in terms of equality in a free Abelian group.

Joint work with Michael Moortgat

13:30–15:30 Lunch

15:30–16:10 **Olivier Laurent.** *Intuitionistic/co-Intuitionistic Nets.*

Starting from the implication-free fragment of intuitionistic logic, we introduce co-intuitionistic logic and the very simple duality that relates these two systems. We show their expressiveness by presenting a translation of call-by-value classical logic into the intuitionistic system and a translation of call-by-name classical logic into the co-intuitionistic one. We present a graphical syntax (inspired by proof-nets of linear logic) for representing proofs and cut elimination in the intuitionistic and co-intuitionistic systems. Through the previously mentioned duality, a given net can be seen both as an intuitionistic proof and as a co-intuitionistic one.

16:10–16:30 **Evgeny Dashkov.** *On intuitionistic logic of proofs.*

The intuitionistic logic of proofs (iLP) was introduced by S. Artemov and R. Iemhoff. It has the intuitionistic propositional axioms, the usual axioms of the classical logic of proofs LP and the axioms for all Visser's rules forming a basis for the admissible propositional rules of HA. iLP was conjectured to be the logic of proofs for HA, i.e., to be complete with respect to the appropriate arithmetical semantics. We prove this conjecture. We also prove the completeness of iLP with respect to a Kripke-style semantics that we introduce and show that iLP is decidable.

16:30–16:50 Coffee

16:50–17:30 Matthias Baaz. *Proof theoretic aspects of cut-elimination by resolution.*

We desribe proof-theoretic consequences of this alternative concept of cut-elimination. We show amongst other results, that the level of quantifier alternations of interpolants for sequents in LK-proofs can be bounded by the length of the original proof with cuts.

Tuesday, May 6. Conference Hall, 9-th Floor

10:30–11:10 Michael Zakharyaschev.

11:10–11:50 Jan Broersen. *Some new challenges for understanding the logical interaction of knowledge and action.*

Systems like product update, dynamic epistemic logic, public announcement logic, etc. aim at modeling the dynamics of epistemic states using dynamic logic. However, using dynamic logic has some drawbacks. In this talk I will address the dynamics of epistemic states using the paradigm of $STIT$ (Seeing To It That) logics. Several new and interesting questions arise by considering the interaction of epistemic and $STIT$ modalities.

11:50–12:10 Coffee

12:10–12:50 Alexander Podkolzin. *A computer solver of mathematical problems.*

Abstract: We have developed a logical processor for solving mathematical problems. This processor is based on a scanning-like procedure, providing some kind of internal "logical vision". The algorithmic language for teaching the solver has two levels. The first level of this language is a logical language for theorems of the subject area. The second level comprises a logical formulation of decision rules controlling applications of theorems, and a list of specifications for a compiler. Such a combination of logical levels makes our description of powerful algorithmic transformations compact and intuitively clear. The result of teaching the solver is a computer mathematics system of a new type. This system not only gives answers for concrete problems, but demonstrates the whole process of solving step-by-step, with text-formula comments. The solver has more than 25000 algorithmic rules (methods) for problem solving in such areas as elementary algebra, elementary geometry, analytic geometry and elements of linear algebra, calculus, differential equations, probability, complex analysis.

12:50–13:30 Paolo Turrini. *A Deontic Logic for Socially Optimal Norms.*

In the talk I will deal with game-theoretical notions like Pareto Optimality and Domination proposing a Deontic Language that imposes coalitions of agents to choose in accordance to what is best for society as a whole. I will discuss some properties of the language and further developments of the research. The work is joint with Jan Broersen, Rosja Mastop and John-Jules Meyer.

13:30–15:30 Lunch

15:30–16:10 Paul-André Méllies. *The 2-dimensional algebra of negation.*

Is it possible to think of a proof as a particularly clever kind of knot? In this talk, I will explain how the two combinatorial structures (knots and proofs) may be formulated in the same algebraic framework coming from low dimensional topology and categorical algebra. This analogy between proofs and knots clarifies the relationship between game semantics and linear logic, and leads to an algebraic presentation of logic by generators and relations. It also uncovers a series of promising connections with mathematical physics, which I will illustrate at the end of the talk.

16:10–16:50 Vincent van Oostrom. *Z, proving confluence by monotonic single-step upperbound functions.*

Abstract: We introduce the Z-property of rewrite systems. It was originally conceived for proving confluence of braids and related systems. We study the Z-property itself, relating it to known confluence methods for abstract rewriting systems, and show it applies to orthogonal term rewriting systems as well as to various lambda calculi, both beta and beta-eta and both with or without explicit substitutions, and argue that the resulting confluence proofs might be the simplest ones known. We conclude with giving some examples of confluent rewrite systems which do not have the Z-property and conjecture that (untyped) lambda calculus with restricted eta-expansion is one of them. Joint work with Patrick Dehornoy.

16:50–17:10 Coffee

17:10–17:50 Lutz Strassburger. *What is Deep Inference? — An Overview..*

Deep Inference is a proof theoretic paradigm that allows to rewrite formulas deep inside arbitrary contexts. Thus, it is very different from shallow formalisms, like the sequent calculus, where formulas are decomposed along their main connective. In the talk I will give an overview of the research results on deep inference within the last 7 years. In particular, I will focus on the new expressivity and modularity in the design of deductive systems, novel methods for proving cut elimination, new kinds of normal forms for proofs, and possible exponential speed-up for proofs of Boolean tautologies.

18:00–20:30 Reception

Wednesday, May 7. Conference Hall, 9-th Floor

10:30–11:10 Valery Plisko. *On realizable propositional formulas.*

A brief survey of known results on the realizable propositional formulas will be given. A special attention will be paid to the relations between various partial results in this area.

11:10–11:50 Ilya Shapirovsky. *Decision procedures for transitive modal logics via conditional satisfiability.*

We introduce the notion of conditional satisfiability and show how it can be used to construct simple and space-saving decision procedures for transitive modal logics. To illustrate it, for various modal logics we prove $PSPACE$-decidability and describe polynomial-space algorithms in an explicit form.

11:50–12:10 Coffee

12:10–12:50 Volodya Shavrukov. *Around the E-tree.*

The talk is an overview of old and recent progress concerning the E-tree, i.e. the partial order of inclusion among the prime filters of the lattice of Σ_1 sentences modulo provability in PA, with emphasis on open problems.

12:50–13:30 Rosalie Iemhoff. *Translations and Kripke models for constructive set theories.*

Constructive set theories form a foundation for constructive mathematics in the same was as Zermelo-Fraenkel set theory is meant to be a foundation for classical mathematics. In this talk we will discuss two aspects of constructive set theories. First we will introduce a translation that can be seen as an analogue of Friedman's translation for Heyting Arithmetic. The presence of the extensionality axiom blocks the applicability of Friedman's translation itself in the setting of constructive set theories, but one can define an alternative translation, in a way similar to the realizability interpretation of these theories, that does have the right properties. In the second part of the talk we will discuss the construction of certain Kripke models for constructive set theories that use two model constructions from classical set theory.

13:30–15:30 Lunch

15:30–16:10 Georg Moser. *The Epsilon Calculus and Herbrand Complexity.*

The talk investigates the epsilon theorems for first-order logic with equality and the complexity of the elimination procedure underlying their proof, as well as the length of Herbrand disjunctions of existential theorems obtained by this elimination procedure.

16:10–16:50 Stefan Hetzl. *Proof Fragments, Cut-Elimination and Cut-Introduction.*

Cut-elimination is one of the most fundamental proof transformations in logic. Ceres (cut-elimination by resolution) is a cut-elimination method for first-order classical logic. It works in two phases: First, a proof is split into its cut-free parts, leaving some atomic formulas - as residue of the cuts - in their end-seqents. Secondly, a re-composition of these parts is calculated by using a resolution theorem prover. The result is a proof that consists of instances of these cut-free parts connected by cuts on only atomic formulas (which can be eliminated easily).

In this talk we show that this structure of normal forms is not a specific feature of the Ceres-method but is instead a general phenomenon of cut-elimination: We consider a standard proof rewrite system without restrictions on the employed strategy and show that each normal form is a composition of instances of these cut-free parts. The notion of 'cut-free part' of a proof is formalized based on proof skeletons (which are abstract representations of the structure of proofs).

This result is used for giving a (partial) description of the redundancy of a cut-free proof w.r.t. cut-introduction. As a corollary, a lower bound on cut-introduction is obtained.

The talk investigates the epsilon theorems for first-order logic with equality and the complexity of the elimination procedure underlying

their proof, as well as the length of Herbrand disjunctions of existential theorems obtained by this elimination procedure.

16:50–17:10 Coffee

17:10–17:50 **Dmitry Skvortsov.** *On embeddings of superintuitionistic predicate logics of some classes of Kripke frames.*

The logics (with and without equality) of all predicate Kripke frames with nested domains based over a fixed poset W (a set of possible worlds) are embeddable in the logic (without equality) of all Kripke frames with constant domains over W. Therefore Takano's result on finite axiomatizability of the logic of Kripke frames with constant domains over the set of real numbers implies the recursive axiomatizability of the corresponding logics with nested domains. Other consequences follow as well.

Wednesday, May 8. **Conference Hall, 9-th Floor**

10:30–11:10 Valentin Shehtman. *On modal and superintuitionistic first order logics with equality.*

11:10–11:40 Yuri Savvateev. *The derivability problem for Lambek calculus with one division.*

The derivability problem for associative Lambek calculus L was proved to be NP-complete by M.Pentus. The same problem for $L(\backslash)$, a part of associative Lambek calculus called Lambek calculus with one division, was an open problem. Here we present a polynomial algorithm for determining wether a given sequent is derivable in $L(\backslash)$.

11:40–12:00 Coffee

12:00–12:40 Morteza Moniri. *Intuitionistic bounded arithmetic.*

In this talk I consider several theories of intuitionistic bounded arithmetic and explain some old and new results concerning them. There are two apparently different definitions of intuitionistic bounded arithmetic hierarchy. I show that these two are equivalent by using basic proof theory of arithmetic. Moreover, I relate the collapse of this hierarchy to the collapse of the polynomial hierarchy. For this I give a simple proof based on Kripke model theory.

12:40–13:10 Rostislav Yavorskii. *On automatic verification of pointer machines.*

Pointer machine is a formal model of computation which is powerful enough to fairly model dynamic semantic for Java-like programming languages. At the same time, in some natural cases one-step behavioral properties of pointer machines turn out to be decidable. The goal of our ongoing project is to develop a tool set for automated analysis of pointer machines by means of different proof checkers. Joint work with Dmitriy Ermolov.

13:10–13:20 Coffee

13:20–14:00 **Norbert Preining.** *Quantified Propositional Gödel Logics.*

In 1932, Gödel introduced a family of finite-valued propositional logics to show that intuitionistic logic does not have a characteristic finite matrix. The propositional Gödel logics are well understood: Any infinite set of truth-values characterizes the same set of tautologies.

Propositional Gödel logic can be extended by quantifiers in different ways, in particular by first-order quantifiers (universal and existential quantification over object variables) and propositional quantifiers (universal and existential quantification over propositions).

While there is only one infinite-valued propositional Gödel logic, uncountably many different quantified propositional Gödel logics are induced by different infinite subsets of truth-values over $[0, 1]$.

In contrast to classical propositional logic, propositional quantification may increase the expressive power of Gödel logics. More precisely, statements about the topological structure of the set of truth-values (taken as infinite subsets of the real interval [0,1]) can be expressed using propositional quantifiers.

We present recent (and not so recent) results dealing with decidability, axiomatisability, and quantifier elimination for certain quantified propositional Gödel logics.

14:00–14:10 Closing