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PLENARY TALKS

► PABLO BARCELÓ, *Characterizing classes of conjunctive queries that can be efficiently evaluated*.
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Conjunctive Queries (CQs), and unions thereof, have important applications in computer science; e.g., they correspond to the core of standard query languages for extracting information in relational databases and define the language for specifying constraints in the area of constraint satisfaction. In logical terms, unions of CQs coincide exactly with the class of existential positive FO formulas. Since in general evaluating a CQ is a computationally intractable problem, there has been a flurry of activity on identifying fragments of the class of CQs that can be efficiently evaluated.

A celebrated result due to Grohe states that the classes of CQs that can be efficiently evaluated are precisely those for which there is a bound on the treewidth of their primal graph (modulo equivalence). In this talk we start by presenting a proof of this result, and then continue by showing some of our recent results that establish extensions of Grohe's characterization to the case when the underlying structure satisfies additional semantic information in the form of logical rules.

▶ MANUELA BUSANICHE, *Algebraic semantics of substructural logics: constructions of residuated lattices.*
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Substructural logics encompass many interesting logics: intuitionistic logic, fuzzy logic, relevance logic, linear logic, many-valued logics. They are logics that, when formulated as Gentzen-Style systems, lack some of the three basic structural rules: contraction, weakening or exchange. Their algebraic semantics are based on residuated lattices, therefore the analysis of these mathematical structures constitute an important tool to understand and study those logical systems uniformly.

The study of substructural logics from the semantical point of view, as systems whose algebraic models are residuated structures settles a new perspective, where mathematics becomes the main tool of research. But the multitude of different structures makes the study complicated, thus the investigation of interesting subvarieties of residuated lattices is an appealing problem to address. In this talk, we will present some mathematical constructions of residuated lattices from simpler or better-known structures. We will define the subvarieties of residuated lattices whose members are built using these constructions, and we will explain the logical applications of our study.

▶ ZOÉ CHATZIDAKIS, *Notions of difference closure of difference fields.*
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It is well known that a differential field K of characteristic 0 is contained in a differential field which is differentially closed and has the property that it K-embeds in every differentially closed field containing K. Such a differential field is called a differential closure of K, and it is unique up to K-isomorphism. In other words, prime models exist and are unique. The proof uses the fact that the theory of differentially closed fields of characteristic 0 is totally transcendental.

One can ask the same question about difference fields: do they have a difference closure, and is it unique? The immediate answer to both these questions is no, for trivial reasons: in most cases, there are continuum many ways of extending an automorphism of a field to its algebraic closure. Therefore a natural requirement is to impose that the field K be algebraically closed. Similarly, if the subfield of K fixed by the automorphism is not pseudo-finite, then there are continuum many ways of extending it to a pseudo-finite field, so one needs to add the hypothesis that the fixed subfield of K is pseudo-finite.

In this talk I will first show by an example that even these two conditions do not suffice.

There are two (and more) natural strengthenings of the notion of difference closedness, and we show that in characteristic 0, these notions do admit unique prime models over any algebraically closed difference field K, provided the subfield of K fixed by the automorphism is large enough. Translated into algebraic terms, they give rise to natural notions.

In model-theoretic terms, this corresponds to the existence and uniqueness of a-prime and kappa-prime models.

In characteristic $p > 0$, no such result can hold.

All concepts and definitions will be introduced during the talk.

► MICHAEL HRUŠÁK, *Ultrapowers in topology.*
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In a joint work with U.A. Ramos Garcia, J. van Mill and S. Shelah we show how the ultrapower construction can be used to solve old problems of Comfort and van Douwen concerning countably compact topological groups.

▶ ELAINE PIMENTEL, *Sequentialising nested systems.*
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Starting with a semantical motivation, we investigate the proof theoretic connections between sequent and nested proof calculi. Specifically, we identify general conditions under which a nested calculus can be transformed into a sequent calculus by restructuring the nested sequent derivation (proof) and shedding extraneous information to obtain a derivation of the same formula in the sequent calculus. These results are formulated generally so that they apply to calculi for intuitionistic, normal modal logics and negative modalities. We end by showing how this work provides a new insight into the discussion of the bounds for analyticity in sequent systems.

▶ CRISTÓBAL ROJAS, *Computability and complexity in the analysis of dynamical systems.*
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Ever since the first numerical studies of chaotic dynamics appeared in the early 1960's, it has become commonly accepted among practitioners that computers cannot, in general, be used to make deterministic predictions about future behavior of non-linear dynamical systems. Instead, the standard practice now is to make statistical predictions. This approach is based on the Monte Carlo method, pioneered by Ulam and von Neumann at the dawn of the computing age. It is universal and powerful – and only requires access to the dynamical system as a black box, which is then subjected to a number of statistical trials. We consider the simplest non-linear discrete dynamical systems, given by the logistic maps $f_a(x) = ax(1-x)$ of the interval $[0,1]$. We show that there exist real parameters $a \in (0,4)$ for which almost every initial condition in $[0,1]$ has, under iteration by f_a, the same statistical distribution in $[0,1]$, but this limiting distribution is not Turing computable. In particular, the Monte Carlo method cannot be applied to study these dynamical systems.

▶ HENRY TOWSNER, *Interpreting infinity within finite mathematics.*
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Sometimes concrete theorems in combinatorics, algebra, and other areas about finite or countable objects have indirect proofs which pass through abstract set theoretic arguments—tools like ultraproducts, uncountably infinite sets, and sometimes even forcing (just to prove an absolute theorem about the ground model). By arguments about countable substructures of models of ZFC, it cannot truly be necessary to use these tools. If these tools are not mathematically necessary, there should be some other reason that mathematicians end up using them. In this talk, I will argue that many of these infinitary techniques serve to clarify proofs: they can be viewed as translations from complicated, hard to understand finite arguments to more abstract but easier to understand infinitary arguments.

MINI COURSES

▶ SANTIAGO FIGUEIRA, *A Computer-theoretical outlook on foundations of quantum information.*
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We introduce non-locality, a phenomenon by which measuring a property of a quantum system can instantaneously determine the results of another property measured on a distant system. We study Bell tests and its connection to non-locality and non-signaling distributions. We also present some notions of computability and randomness. We study what happens when we amalgamate notions of learnability, randomness and computability on the one hand and Bell scenarios for testing non-locality on the other. We present a new loophole for Bell-like experiments. We prove that choosing the inputs for a Bell tests using private pseudorandom number generators allows an adversary to prepare local boxes that pretend to be non-local. We also explain why deterministic hidden-variable models of non-local correlations need to be uncomputable if we want to prevent those correlations from being signaling.

▶ JAROSLAV NEŠETŘIL, *Ramsey in context.*
Charles University, Czech Republic.
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The lectures will be concentrated around the following topics:

- Many faces of Ramsey Theory
- Ramsey classes, classification problem
- automorphisms, lifts and expansions

▶ CARLES NOGUERA, *Logic and implication: an introduction to the general algebraic study of non-classical logics.*
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The goal of this short course is to give an overview of the general theory of weakly implicative logics, which provides an algebraic approach to logics with a reasonable implication connective (hence, covering the majority of non-classical logics studied in the literature). Namely, we will follow the next plan:

1. Basic syntactical notions. Introduction of important examples (classical logic, intuitionistic logic, Lukasiewicz logic, Gödel-Dummett logic, BCI, and BCK). Completeness w.r.t. the general matrix semantics. Weakly implicative logics and completeness w.r.t. reduced models. Finitary logics and completeness w.r.t. relatively subdirectly irreducible matrices. Characterizations of completeness properties w.r.t. arbitrary classes of models.

2. Substructural logics and their axiomatizations, algebraic semantics, deduction theorems and proof by cases properties. Generalized disjunctions. Semilinear logics as systems that are complete w.r.t. linearly ordered models: characterizations, axiomatizations, and densely ordered semantics.

▶ HÉCTOR PASTÉN, *Hilbert's tenth problem beyond* $\mathbb{Z}$.
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Hilbert's tenth problem asked for an algorithm to decide solvability of diophantine equations over the integers. The works of Davis, Putnam, Robinson and Matiyasevich showed that the requested algorithm does not exist. However, the analogous problem remains open in a number of important cases such as the field of rational numbers and rings of integers of number fields. This mini-course aims to present some of the main techniques in this very active area of research.

Outreach Conference

▶ WALTER CARNIELLI, *On Lighter Logics: Getting Rid of the Burden of Explosion, and the Paraconsistency Program.*
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La charla será en español, con presentación en inglés. The talk will be Spanish, with slides in English.

Independently whether contradictions and falsehoods may occur in the physical universe, they certainly occur in our language and in our reasoning. As standard logic is constructed to found science and mathematics, it carries a heavy weight, inappropriate to the contradictions and paradoxes in common reasoning. Paraconsistent logic is a lighter logic that has gained importance by its role in preventing deductive explosion in common reasoning and in huge unstructured databases as big data and the World Wide Web. This talk is dedicated to discuss the Paraconsistency Program and its developments in philosophy, probability and credal calculi, information, semantics, and in the problems in the foundations of mathematics.