Tagungsbericht 06/1998

Endliche Modelltheorie

08.02.–14.02.1998

The workshop was organized by H.-D. Ebbinghaus, J. Flum (both Freiburg), and Y. Gurevich (Ann Arbor). The program consisted of 27 talks, an open problem session organized by E. Grädel and J. Tyszkiewicz, and a panel discussion on the connection between finite model theory and stability theory suggested by J. Baldwin.

Semistructured Data and Transitive Closure Logic

Natacha Alechina (joint work with Maarten de Rijke)

Semistructured data is a collection of data which does not conform to a fixed database schema, but at the same time has some structure: e.g. heterogeneous databases or the World Wide Web.

We characterise expressive power of some description and query languages for semistructured data, namely:

1. Graph schemas proposed by Buneman et al. have the same expressive power as a (possibly infinite) set of universal formulas from the 'guarded fragment 2' of first order logic.

2. Data guides (Abiteboul et al.) have the same expressive power as an existential first order formula from the 'guarded fragment 2' of first order logic.

3. Path constraints (Abiteboul and Vianu) correspond to a proper fragment of the transitive closure logic.

4. Path queries with regular expressions correspond to a proper fragment of the transitive closure logic.

Embedded Finite Models

John Baldwin (joint work with Michael Benedikt)

We show that the expressive power of first-order logic over finite models embedded in a model M is determined by stability-theoretic properties of M. In particular, we show that if M is stable, then every property of finite structures that can be expressed by embedding the structure in M can be expressed in pure first-order logic. We also show that if M does not have the independence property, then any property of finite structures that can be expressed by embedding the structures in M, can be expressed in first-order logic over a dense linear order. This extends known results on the definability of classes of finite structures and ordered finite structures in the setting of embedded finite models. We show that if M is a model of a stable theory T, I is a set of indiscernibles in T and (M, I) is elementarily equivalent to (M_1, I_1) where M_1 is I_1^+-saturated, then every permutation of I extends to an automorphism of M and the theory of (M, I) is stable.

Choiceless Polynomial Time

Andreas Blass (joint work with Yuri Gurevich and Saharon Shelah)

We present a model intended to describe polynomial time computation where inputs are finite unordered structures, parallelism is allowed, but arbitrary choices are forbidden. The model is a version of Gurevich's abstract state machines, where the states include the universe of hereditarily finite sets over the input structure. "Polynomial time" refers to the number of elementary steps of all the parallel subcomputations, and it is measured relative to the number of elements of the input structure. We show, among other things, that

1. when the input is an unstructured set, the parity of its cardinality cannot be computed in choiceless Ptime, and
2. when the input is a bipartite graph with equal-sized parts, the existence of a complete matching cannot be decided in choiceless Ptime.

The proofs combine Ehrenfeucht-Fraïssé games with symmetry considerations based on a combinatorial exploitation of the time bound.

Asymptotics for Finite Models

Kevin Compton

Finite model theory is a field that developed under the influence of three areas: logic, computer science and combinatorics. While the emphasis is often on the first two, we should not overlook the potential for FMT to play the same role for combinatorics that model theory has played for algebra: it can clarify and lead to a deeper understanding. We illustrate this thesis by describing how work on 0-1 laws can lead to a deeper understanding of combinatorial enumeration and, in particular, to generating function methods. We survey some older results, and more recent work (with S. Burris, A. Odlyzko, and B. Richmond), on the existence of 0-1 laws for classes where structures are built from indecomposable structures using operations such as direct sum and product. We give necessary and sufficient conditions for 0-1 laws to hold for a class in terms of characteristics of the generating function for the class.

Finite Variable Types with Generalized Quantifiers

Anuj Dawar

We consider the definability of the finite variable equivalence relations $\equiv^{k,\mathbf{Q}}$ for sets of generalized quantifiers $\mathbf{Q}$. We show that for finite collections $\mathbf{Q}$ the equivalence relation is always definable, and indeed, the equivalence classes are ordered in the logic PFP($\mathbf{Q}$) which is the extension of the partial fixed point logic with the quantifiers in $\mathbf{Q}$. Such an ordering of the equivalence classes is also definable in $\mathrm{SO}^{\omega}(\mathbf{Q})$, the extension of the restricted second order logic SO^{ω} with the quantifiers $\mathbf{Q}$. However, we show that it is not necessarily definable in IFP($\mathbf{Q}$). Indeed, we construct a single, polynomial time computable quantifier Q for which the equivalence relation $\equiv^{k,Q}$ is not definable in IFP(Q). Finally, we also obtain some positive definability results for IFP(Q), showing for particular quantifiers Q that it can define an ordering of the $\equiv^{k,Q}$ classes, as well as showing general constructions of quantifiers which have this property.

The Closure of Monadic NP

Ron Fagin (joint work with Miklos Ajtai and Larry J. Stockmeyer)

It is a well-known result of Fagin that the complexity class NP coincides with the class of problems expressible in existential second-order logic (Σ_1^1), which allows sentences consisting of a string of existential second-order quantifiers followed by a first-order formula. *Monadic NP* is the class of problems expressible in monadic Σ_1^1, i.e. Σ_1^1 with the restriction that the second-order quantifiers are all unary, and hence range only over sets (as opposed to ranging over, say, binary relations). For example, the property of a graph being 3-colorable belongs to monadic NP, because 3-colorability can be expressed by saying that there exists three sets of vertices such that each vertex is in exactly one of the sets and no two vertices in the same set are connected by an edge. Unfortunately, monadic NP is not a robust class, in that it is not closed under first-order quantification. We define *closed monadic NP* to be the closure of monadic NP under first-order quantification and existential unary second-order quantification. Thus, closed monadic NP differs from monadic NP in that we allow the possibility of arbitrary interleavings of first-order quantifiers among the existential unary second-order quantifiers. We show that closed monadic NP is a natural, rich, and robust subclass of NP. As evidence for its richness, we show that not only is it a proper extension of monadic NP, but that it contains properties not in various other extensions of monadic NP. In particular, we show that closed monadic NP contains an undirected graph property not in the closure of monadic NP under first-order quantification and Boolean operations. Our lower-bound proofs require a number of new game-theoretic techniques.

Existential Second Order Logic Over Strings

Georg Gottlob (joint work with Thomas Eiter and Yuri Gurevich)

Existential second order logic (ESO) and monadic second order logic (MSO) have attracted much interest in logic and computer science. ESO is a much more expressive logic over word structures than MSO. However, little was known about the relationship between syntactic fragments of ESO and MSO. We shed light on this issue by completely characterizing this relationship for the prefix classes of ESO over strings (i.e., finite word structures). Moreover, we determine the complexity of model checking over strings, for all ESO-prefix classes. Let ESO(Q) denote the ESO prefix class with first-order quantifier prefix from prefix set Q. We show that ESO(E*AE*)=ESO(Ackermann) and ESO(E*AA) are the maximal standard ESO-prefix classes contained in MSO, thus expressing only regular languages. We further prove the following dichotomy theorem: an ESO prefix-class either expresses only regular languages (and is thus semantically contained in MSO), or it expresses some NP-complete languages. We also give a precise characterization of those ESO-prefix classes which are equivalent to MSO over strings, and of the ESO-prefix classes which are closed under complement on strings.

Guarded Sentences

Erich Grädel

The guarded fragment (GF) and the loosely guarded fragment (LGF) of first-order logic are two interesting generalizations of modal logic that increase the expressive power of modal logics while preserving their nice algorithmic and model-theoretic properties.

I present the following results, partly due to Andreka, van Benthem and Nemeti, partly due to myself:

1. Both GF and LGF are decidable and have the tree model property.
2. Both GF and LGF are complete for 2EXPTIME.
3. GF has the finite model property (this result is based on the tree model property and on Herwig's Theorem).

Further, I briefly discuss a game-based analysis of guarded types and guarded theories of finite structures.

Fixed-Point Logics on Planar Graphs

Martin Grohe

We study the expressive power of inflationary fixed-point logic IFP and inflationary fixed-point logic with counting IFP+C on planar graphs. We prove the following results:

1. IFP captures polynomial time on 3-connected planar graphs, and IFP+C captures polynomial time on arbitrary planar graphs.

2. Planar graphs can be characterized up to isomorphism in a logic with finitely many variables and counting. This answers a question of Immerman.

3. The class of planar graphs is definable in IFP. This answers a question of Dawar and Grädel.

Algebraic Characterizations and a Complete Problem for Deterministic Linear Time

Etienne Grandjean (joint work with Thomas Schwentick)

Linear time is an intuitive and widespread notion of algorithm designers. However, contrarily to polynomial time, it is generally admitted that it lacks a precise and robust formalization and seems a more delicate matter.

In this talk, we recall that deterministic linear time on RAMs, denoted DLIN, can be defined in a rather robust way. The intrinsic interest of the complexity class DLIN is enhanced by the following two recent results that we shall present in the talk: – DLIN has an algebraic (machine-independent) characterization using a simple recursive scheme; – as a consequence, we exhibit a DLIN-complete problem which is natural in some sense; moreover, it is interesting to note that the involved reductions can be defined in a very strict and machine-independent way.

Finite Model Theory: Personal Perspective

Yuri Gurevich

We try to make a case that finite model theory should grow to the model theory of computer science.

Descriptive Complexity: Where We Are and Where We May Go

Neil Immerman

I have recently completed "Descriptive Complexity," to appear in Springer Verlag Graduate Texts in Computer Science, 1998. In this talk I summarize the conclusions chapter. I describe what I feel are some of the major accomplishments to date, and some challenging directions where descriptive complexity and finite model theory can and should go.

Conjunctive-Query Containment and Constraint Satisfaction

Phokion G. Kolaitis, Moshe Y. Vardi

Conjunctive-query containment is recognized as a fundamental problem in database query evaluation and optimization. At the same time, constraint satisfaction is recognized as a fundamental problem in artificial intelligence. What do conjunctive-query containment and constraint satisfaction have in common? We point out that, despite their very different formulation, conjunctive-query containment and constraint satisfaction are essentially the same problem. The reason is that they can be recast as the following fundamental algebraic problem: given two finite relational structures A and B, is there a homomorphism from A to B? As formulated above, the homomorphism problem is uniform in the sense that both relational structures A and B are part of the input. By fixing the structure B, one obtains the following non-uniform problem: given a finite relational structure A, is there a homomorphism from A to B? We review first prior work by Feder and Vardi about the complexity of non-uniform constraint satisfaction.

In general, non-uniform tractability results do not uniformize. Thus, it is natural to ask: which tractable cases of non-uniform tractability results for constraint satisfaction and problems do indeed uniformize. We exhibit three non-uniform tractability results that uniformize and, thus, give rise to polynomial-time solvable cases of constraint satisfaction and conjunctive-query containment. We begin by examining the tractable cases of Boolean constraint-satisfaction problems and show that they do uniformize. This can be applied to conjunctive-query containment via binarization; in particular, it yields one of the known tractable cases of conjunctive query containment. After this, we show that tractability results for constraint-satisfaction problems that can be expressed using Datalog programs with bounded number of distinct variables also uniformize. Finally, we establish that tractability results for queries with bounded treewidth uniformize as well.

Toplogical Spaces of Generalized Quantifiers

Kerkko Luosto

Generalized quantifiers with vocabulary τ can be seen as a topological space which is homeomorphic to the Cantor space. Some important classes of quantifiers are closed subsets of this space. Using this kind of topological ideas one can prove results in quantifier definability theory such as the following:

Theorem. Suppose that a monadic universe-independent quantifier Q is definable in terms of monadic simple quantifiers. Then Q is defnable by means of cardinality quantifiers.

Estimating the Size of Definable Relations

Jim Lynch

In many database applications, an estimate of the size of a definable relation, rather than the relation itself, is desired. Thus there are advantages if the size can be computed more quickly than actually evaluating the relation itself, even if the answer is only an approximation. In certain cases, this is possible. Two general approaches to fast estimation of the size are described: adaptive sampling and Monte Carlo estimation. Both approaches are illustrated by estimating the size of the transitive closure of a graph.

Adaptive sampling is based on the idea that the size A of the transitive closure is the sum of the sizes of the reachability sets of the vertices. The procedure makes a random choice of a vertex, computes the size of its reachability set, and adds it to a running sum S. After k samples are taken, the estimate of the size is S/k, multiplied by n, the number of vertices of the graph. Papers by Lipton, Naughton, Schneider, and Seshadri claim that for any probability p and constant b, there is a constant c such that if $S \geq cn$, then the estimate is within bA of A with probability p. However, they do not give a complete proof of their claim. In this talk, it is proven that if $S \geq cn \log n$, then the estimate has the above accuracy with probability p. It is also shown that the method extends to estimating the transitive closure of any first-order definable binary relation, and on graphs of bounded degree, it runs in time linear in n. The proof uses Hanf's characterization of the first-order type of a tuple in terms of its neighborhood.

The other approach to size estimation, Monte Carlo, approximates the size of the transitive closure in a very different way. It is based on the statistical method of estimating the size of a subset B of a finite set A. Assume that an ordering on A is generated by randomly assigning each vertex a real number value. Let b be the minimum value of any vertex in B. Repeat the process k times, remembering b each time. At the end, estimate the size of B as the reciprocal of the $k(1-1/e)$-th smallest b. In order to use this method to compute the size of the transitive closure efficiently, it is necessary to find the minimum values without actually determining each reachability set. An algorithm due to E. Cohen is presented which accomplishes this in time linear in n, and by taking k large enough, it gives an estimate within bA of A with probability p. Again, it is shown how this algorithm can be generalized to the transitive closure of first-order definable binary relations on graphs of bounded degree.

Invariant Definability as Unifying Framework for Uniform and Non-uniform Complexity Classes

Janus Makowsky

We present a unified framework which allows us to capture uniform and non-uniform complexity classes with various logics. For this purpose we define formally the notion of *invariant definability* in a logic $\mathcal{L}$ and study it systematically. We relate it to other notions of definability (implicit definability, Δ-definability and definability with built-in relations) and

Gefördert durch DFG Deutsche Forschungsgemeinschaft

establish connections between them. In descriptive complexity theory, invariant definability is mostly used with a linear order (or a successor relation) as the auxiliary relation. We formulate a conjecture which spells out the special role linear order plays in capturing complexity classes with logics and prove two special cases.

Observing that the class of linear orders is

1. closed under substructures and

2. has one model (up to isomorphism) in each finite cardinality,

we also show that in any other class K of finite structures (closed under isomorphisms) and sharing the above two properties linear orders are parametrically FOL-definable. In other words, (1) and (2) spell out a special property of linear orders which may be viewed desirable from the point of view of invariant definability.

We look at the non-uniform complexity classes **P**/*poly* and its variations **L**/*poly*, **NL**/*poly*, **NP**/*poly* and **PSpace**/*poly*, and look for analogues of the Ajtai-Immerman theorem which characterizes $\mathbf{AC}_0$ as the non-uniformly First Order Definable classes of finite structures. We have previously observed that the Ajtai-Immerman theorem can be rephrased in terms of *invariant definability*: A class of finite structures is FOL invariantly definable iff it is in $\mathbf{AC}_0$.

Our main result here can be stated as follows: Let **C** be one of **L**, **NL**, **P**, **NP**, **PSpace** and $\mathcal{L}$ be a logic which captures **C** on ordered structures. Then the $\mathcal{L}$-invariantly definable classes of (not necessarily ordered) finite structures are exactly the classes in **C**/*poly*. We also consider uniformity conditions on the advice sequences and obtain analogous results.

Similar results were described previously by using definability with numeric predicates and similar notions by B. Molzan, A. Atserias and J. L. Balcazar.

On Representing Sets of Natural Numbers in Finite Models

Marcin Mostowsky

Attempts of transforming theorems from the general case (allowing infinite models) to finite model theory force us to represent some infinite sets of natural numbers in finite models. Paricularly this is so when we try to apply the mehtod of truth-definitions, invented by Tarski, in finite case.

We consider the following definition of representability in finite models: $R \subseteq \omega^n$ is FM-represented by $\phi(x_1, \ldots, x_n)$ iff

$$\forall k \exists m (\forall M \models \mathrm{ST})(\mathrm{card}(M) < k \Rightarrow (\forall a_1, \ldots, a_n \leq k)(R(a_1, \ldots, a_n) \Leftrightarrow M \models \phi(a_1, \ldots, a_n))),$$

where ST is a theory describing an initial segment of the natural numbers and **a** stands for $a_1, \ldots, a_n$. We prove the following:

Theorem. $R \subseteq \omega^k$ is RM-represented by some formula iff R is up to degree $0'$ (recursive in some r. e. set).

Constraint Verification

Greg McColm

Compton [1983] and Andreka et al. [1996] have introduced a *constrained quantification*,

$$\varphi(\bar{x},\bar{y}) \equiv (\exists \bar{y}\colon R(\bar{x},y))\theta(\bar{x},y,\bar{z}) \equiv \exists y[R(\bar{x},y) \wedge \theta(\bar{x},y,\bar{z})],$$
$$\psi(\bar{x},\bar{z}) \equiv (\forall y\colon R(\bar{x},y))\theta(\bar{x},y,\bar{z}) \equiv \forall z[R(\bar{x},y) \rightarrow \theta(\bar{x},y,\bar{z})].$$

Call this logic FO_*. It has the obvious Ehrenfeucht game, and we can thus prove, e.g., that as in LFP, the alternation hierarchy does not collapse. We can define Least Fixed Points on FO_*, and we find, if R is connected, that all FO + LFP queries are (FO_* + LFP)-expressible, on *finite* structures.

But we get a finer measure of the complexity of LFP queries. For example, on a structure $\mathfrak{D} = \langle D, U, a\rangle$, U unary, if we have an operative system of positive FO_*-formulas of subformula depth 1, we can represent $\exists x U(x)$ by a recursion:

$$\begin{aligned} \varphi_0(S_1,S_2) &\equiv S_1(a) \\ \varphi_1(x,S_1,S_2) &\equiv U(x) \vee S_2(x) \\ \varphi_2(x,S_1,S_2) &\equiv (\exists y\colon R(x,y))S_1(y) \end{aligned}$$

with R somehow 'imposed' on D. Then this single *unconstrained* quantification takes time $O(|D|)$ (and time $\Theta(|D|)$ for some R), the time taken determined by R — a possibly more realistic measure of the quantification.

The Modal Fragment of Ptime

Martin Otto

Consider the class of all those properties of worlds in finite Kripke (or of states in finite transition systems) structures, that are

- recognizable in polynomial time, and
- closed under bisimulation equivalence.

It is shown that the class of these *bisimulation-invariant Ptime queries* has a natural logical characterization. It is captured by the straightforward extension of propositional μ-calculus to arbitrary finite dimension. Bisimulation-invariant Ptime, or the *modal fragment of Ptime*, thus proves to be one of the very rare cases in which a logical characterization is known in a setting of unordered structures.

It is also shown that higher-dimensional μ-calculus is undecidable for satisfiability in finite structures, and even Σ^1_1-hard over general structures. This is true even for the two-dimensional variant of the μ-calculus (a bisimulation-invariant two-variable logic with the tree model property). Unlike the situation for (infinitary) modal logic, *vectorization* leads to a drastic increase in expressive power for the μ-calculus.

On the First-Order Prefix Hierarchy

Eric Rosen

We investigate the expressive power of fragments of first-order logic defined in terms of prefixes. The main result establishes a strict hierarchy among these fragments over the signature containing a single binary relation. It implies that for each prefix p, there is a sentence φ in prenex normal form with prefix p, over a single binary relation, such that for all sentences θ in prenex normal form, if θ is equivalent to φ, then p can be embedded in the prefix of θ. This proves a conjecture of Grädel and McColm and strengthens a theorem of Walkoe.

Locality of Order-invariant Formulas

Thomas Schwentick (joint work with Martin Grohe)

We show that every order-invariant first-order formula $\phi(\mathbf{x})$ has the following property: there is a d such that if A is a structure, $\mathbf{a}, \mathbf{b}$ are tuples from A and $N_d^A(\mathbf{a}) \cong N_d^A(\mathbf{b})$ (d-neighbourhoods of $\mathbf{a}$ and $\mathbf{b}$ are isomorphic), then $A \models \phi(\mathbf{a}) \Leftrightarrow A \models \phi(\mathbf{b})$. This proves a conjecture of Libkin.

Databases over a Fixed Infinite Universe

Michael Taitslin (joint work with Alex Stoulboushkin and Oleg Belegradek)

In the relational model of databases a database is thought of as a finite collection of relations between elements. For many applications it is convenient to pre-fix an infinite domain where the finite relations are going to be defined. Often, we also fix a set of domain functions and/or relations. These functions/relations are infinite by their nature. Some special problems arise if we use such an approach.

We show that there exists a recursive domain with decidable theory in which (1) there is no recursive syntax for finite queries, and in which (2) the state-safety problem is undecidable.

We provide very general conditions on the FO theory of an ordered domain that ensure collapse of order-generic extended FO queries to pure order queries over this domain: the Pseudo-finite Homogeneity Property and a stronger Isolation Property. We further distinguish one broad class of ordered domains satisfying the Isolation Property, the so-called quasi-ominimal domains. This class includes all ominimal domains, but also the ordered group of integer numbers and the ordered semigroup of natural numbers, and some other domains.

We generalize all the notions to the case of finitely representable database states—as opposed to finite states—and develop a general lifting technique that, essentially, allows us to extend any result of the kind we are interested in, from finite to finitely-representable states. We show, however, that these results cannot be transferred to arbitary infinite states.

We prove that safe Datalog-programs do not have any effective syntax.

Monadic Second-Order Logic over Partial Orders

Wolfgang Thomas

Some results are presented which illustrate the use of the automata-theoretic method for showing lower bounds of expressiveness in monadic logic. We consider partial orders in the form of finite (vertex- and edge-labelled) acyclic graphs, assumed here to be of bounded degree. Some special cases are: words (viewed as labelled linear orders), trees, "pictures" (two-dimensional words), and "diamonds" (obtained from pairs of trees whose frontiers are identified leaf by leaf). Using and sharpening Hanf's Theorem over such structures, we obtain a normal form for existential monadic second-order formulas (defining the "monadic NP properties") in terms of finite tiling systems (representing "automata"). Over words and trees, this extends to full monadic second-order logic. Tiling systems are applied to give convenient proofs of the following lower bounds: the class of existential monadic second-order properties is not closed under complementation over diamonds (due to K. Reinhardt), neither over pictures (Giammarresi-Restivo), and the mondic Σ_n-hierarchy over pictures is infinite (joint work with O. Matz).

Asymptotic Probabilities Critically

Jurek Tyszkiewicz (joint work with Pawel Idziak)

I argue that the present state of the art in the theory of asymptotic probabilities is unsatisfactory, because there are essentially very few known connections between separate results. As a remedy I propose to develop a structural theory of asymptotic probabilities, based on interpretations preserving convergence. Indeed, I report the failure of the first attempt to create such a theory, due to the unability to eliminate all the trivialites. On the other hand, the situation is not quite hopeless, as all classes of structures which are convergence immune (i. e., never have a convergence law) for $L^{\omega}_{\infty\omega}$ appear to be mutually interpretable. So a kind of completeness can indeed happen.

Disclaimer: All the results have been obtained in cooperation with Pawel Idziak, but the opinions are mine and do not necessarily reflect his opinions.

Adding For-Loops to First-Order Logic

Jan van den Bussche (joint work with Frank Neven, Martin Otto, and Jurek Tyszkiewicz)

We investigate BQL and FO(FOR), two extensions of first-order logic with for-loops. BQL was introduced by Chandra in 1981 as a variation of RQL, an extension of first-order logic with while-loops (rather than for-loops) introduced by Chandra and Harel in 1980. FO(FOR) is the variation of FO(PFP) where instead of a partial fixpoint operator we use an operator that allows us to iterate a formula exactly as many times as there are tuples in the relation defined by some other formula (possibly with parameters). In contrast to the equivalence of FO(PFP) and RQL, it turns out that FO(FOR) is more powerful than BQL, precisely because of this ability of FO(FOR) to use parameters in the definition of the relation that controls the number of iterations; this ability is not present in BQL. We study the issue of nesting of for-loops both in BQL and in FO(FOR). It turns out that nesting of for-loops matters; if we disallow it in either language we get a weaker language. Again this stands in contrast to the situation in RQL and FO(PFP), where nesting of while-loops does not matter as far as expressive power is concerned. We finally show that FO(FOR) is weaker than FO(IFP) (the extension of first-order logic with the inflationary fixpoint operator) extended with counting.

Fragments of Linear Temporal Logic

Thomas Wilke

The talk is concerned with the question how fragments of linear temporal logic (interpreted in finite linear orderings) can be best characterized effectively. For the following fragments, particular characterizations are presented.

1. The fragment where "eventually in the future" is the only temporal operator one is allowed to use.

2. The fragment where "eventually in the future" and "eventually in the past" are the only operators that one is allowed to use.

3. For each $n \geq 0$, the fragment of future temporal logic whose formulas have nesting depth at most n in the "until" operator.

These characterizations are in terms of structural properties of the syntactic semigroups (minimal automata) associated with the properties definable in the fragment in question.

Stable Models with a Predicate

Martin Ziegler (joint work with Enrique Casanovas)

Let M be a (possibly infinite) L-structure. A subset A of M gives rise to two new structures:

1. The $L(P)$–structure (M, A), where the new unary predicate P is interpreted by A.

2. A with the induced structure on it, which consists of an n-ary relation $\{a \in A^n \mid M \models \phi(a)\}$ for each L–formula ϕ with n free variables.

The set A is said to be *small* if there exists an L-structure N and a subset B such that

1. (M, A) and (N, B) are elementarily equivalent and

2. for every finite subset e of B every type over Be is realized in N.

Theorem. Let M be stable, $A \subset M$ small, and assume A does not have the finite cover property. Then (M, A) is stable.

This theorem generalizes the following theorem by Baldwin and Benedikt: If M is stable and A is a small set of indiscernibles, then (M, A) is stable. (See also the abstract of the talk by J. Baldwin.)

This report was edited by Thomas Wilke.

Gefördert durch DFG Deutsche Forschungsgemeinschaft

Alechina, N.	n.alechina@cs.bham.ac.uk
Baldwin, J.	jbaldwin@uic.edu
Blass, A.	ablass@umich.edu
Caicedo, X.	xcaicedo@uniandes.edu
Compton, K.	kjc@umich.edu
Dawar, A.	a.dawar@swansea.ac.uk
Ebbinghaus, H.-D.	hde@sun2.ruf.uni-freiburg.de
Etessami, K.	kousha@bell-labs.com
Fagin, R.	fagin@almaden.ibm.com
Flum, J.	flum@ruf.uni-freiburg.de
Gottlob, G.	gottlob@dbai.tuwien.ac.at
Grädel, E.	graedel@informatik.rwth-aachen.de
Grandjean, E.	grandjean@info.unicaen.fr
Grohe, M.	martin.grohe@mathematik.uni-freiburg.de
Gurevich, Y.	gurevich@umich.edu
Hella, L.	hella@cc.helsinki.fi
Immerman, N.	immerman@cs.umass.edu
Kolaitis, Ph.	kolaitis@cse.ucsc.edu
Krynicki, M.	krynicki@mimuw.edu.pl
Lautemann, C.	cl@informatik.uni-mainz.de
Luosto, K.	kerkko.luosto@helsinki.fi
Lynch, J.	jlynch@sun.mcs.clarkson.edu
Makowsky, J. A.	janos@cs.technion.ac.il
McColm, G. L.	mccolm@math.usf.edu
Mostowski, M.	marcinmo@plearn.edu.pl
Nurmonen, J.	j.nurmonen@mcs.le.ac.uk
Otto, M.	otto@informatik.rwth-aachen.de
Pacholski, L.	pacholsk@tcs.uni.wroc.pl
Rosen, E.	erosen@informatik.rwth-aachen.de
de Rougement, M.	mdr@lri.fr
Schwentick, Th.	tick@informatik.uni-kiel.de
Stewart, I. A.	i.a.stewart@mcs.le.ac.uk
Stolboushkin, A. P.	aps@4ds.com
Taitslin, M.	michael.taitslin@tversu.ru
Thomas, W.	wt@informatik.uni-kiel.de
Tyszkiewicz, J.	jty@mimuw.edu.pl
Väänänen, J.	jvaanane@cc.helsinki.fi
van den Bussche, J.	vdbuss@luc.ac.be

Vardi, M.	vardi@rice.edu
Weinstein, S.	weinstein@cis.upenn.edu
Wilke, Th.	tw@informatik.uni-kiel.de
Ziegler, M.	ziegler@uni-freiburg.de

For more info on the finite model theory community, please consult <URL:http://speedy.informatik.rwth-aachen.de/WWW/FMT.html>.

Tagungsteilnehmer

Prof.Dr. Natasha Alechina
School of Computer Science
The University of Birmingham

GB-Birmingham B15 2TT

Prof.Dr. John T. Baldwin
Dept. of Mathematics, Statistics
and Computer Science, M/C 249
University of Illinois at Chicago
851 St. Morgan

Chicago , IL 60607-7045
USA

Prof.Dr. Andreas Blass
Department of Mathematics
The University of Michigan
3220 Angell Hall

Ann Arbor , MI 48109-1003
USA

Dr. Jan van den Bussche
Department of Mathematics
Limburgs Universitair Centrum
Universitaire Campus

B-3590 Diepenbeek

Prof.Dr. Xavier Caicedo
Depto. Matematicas
Universidad de Los Andes
Carrera 1a. No. 18-A-10
Apartado Aero 4976-12340

Bogota
COLOMBIA

Prof.Dr. Kevin J. Compton
Elc. Eng. & Comp. Science Dept.
The University of Michigan

Ann Arbor , MI 48109-2122
USA

Prof.Dr. Anuj Dawar
Dept. of Computer Science
University College of Swansea
Singleton Park

GB-Swansea ,SA2 8PP

Prof.Dr. Heinz-Dieter Ebbinghaus
Institut für Math.Logik und
Grundlagen der Mathematik
Universität Freiburg
Eckerstr. 1

79104 Freiburg

Prof.Dr. Kousha Etessami
Bell Labs
Room 2C-303A
700 Mountain Ave.

Murray Hill , NJ 07974
USA

Prof.Dr. Ronald Fagin
IBM Almaden Research Center
650 Harry Rd.

San Jose , CA 95120-6099
USA

Prof.Dr. Jörg Flum
Institut für Math.Logik und
Grundlagen der Mathematik
Universität Freiburg
Eckerstr. 1

79104 Freiburg

Prof.Dr. Georg Gottlob
Inst. für Informationssysteme
Techn. Universität Wien
Paniglgasse 16

A-1040 Wien

Prof.Dr. Erich Grädel
Lehr- u. Forschungsgebiet
Mathem. Grundlagen der Informatik
RWTH Aachen
Ahornstr. 55

52074 Aachen

Prof.Dr. Etienne Grandjean-Greyc
Dept. de Informatique
Universite de Caen

F-14032 Caen Cedex

Martin Grohe
Institut für Math.Logik und
Grundlagen der Mathematik
Universität Freiburg
Eckerstr. 1

79104 Freiburg

Prof.Dr. Yuri Gurevich
Elc. Eng. & Comp. Science Dept.
The University of Michigan

Ann Arbor , MI 48109-2122
USA

Dr. Lauri Hella
Dept. of Mathematics
University of Helsinki
P.O. Box 4

SF-00014 Helsinki

Prof.Dr. Neil Immerman
Department of Computer Science
University of Massachusetts

Amherst , MA 01003
USA

Prof.Dr. Phokion G. Kolaitis
Computer and Information Sciences
University of California

Santa Cruz , CA 95064
USA

Prof.Dr. Michael Krynicki
Institute of Mathematics
University of Warsaw
ul. Banacha 2

02-097 Warszawa
POLAND

Prof.Dr. Clemens Lautemann
Institut für Informatik
Universität Mainz

55099 Mainz

Prof.Dr. Kerkko Luosto
Dept. of Mathematics
University of Helsinki
P.O. Box 4

SF-00014 Helsinki

Prof.Dr. Juha Nurmonen
Dept. of Math. and Computer Science
University of Leicester
University Road

GB-Leicester LE1 7RH

Prof.Dr. James F. Lynch
Dept.of Mathematics & Comp. Science
Clarkson University

Potsdam , NY 13699-5815
USA

Dr. Martin Otto
Lehr- u. Forschungsgebiet
Mathem. Grundlagen der Informatik
RWTH Aachen
Ahornstr. 55

52074 Aachen

Prof.Dr. Janos A. Makowsky
Computer Science Department
TECHNION
Israel Institute of Technology

Haifa 32000
ISRAEL

Prof.Dr. Leszek Pacholski
Institute of Computer Science
University of Wroclaw
ul. Przesmyckiego 20

51 151 Wroclaw
POLAND

Prof.Dr. Gregory L. McColm
Dept. of Mathematics
University of South Florida

Tampa , FL 33620-5700
USA

Prof.Dr. Eric Rosen
Lehrstuhl fuer Math. Grundlagen
in der Informatik
RWTH Aachen

52056 Aachen

Prof.Dr. Marcin Mostowski
Inst. Filoz.
Univ. Warsawski
Krakowskie Przedmiescie 3

00-047 Warszawa
POLAND

Prof.Dr. Michel de Rougemont
Laboratoire de Rech. Informatique
Universite de Paris Sud (Paris XI)
Centre d'Orsay, Bat. 490

F-91405 Orsay Cedex

Dr. Thomas Schwentick
Institut für Informatik
Universität Mainz

55099 Mainz

Prof.Dr. Wolfgang Thomas
Institut für Informatik und
Praktische Mathematik
Universität Kiel

24098 Kiel

Prof.Dr. Iain A. Stewart
Dept. of Math. and Computer Science
University of Leicester
University Road

GB-Leicester LE1 7RH

Prof.Dr. Jurek Tyszkiewicz
Lehr- u. Forschungsgebiet
Mathem. Grundlagen der Informatik
RWTH Aachen
Ahornstr. 55

52074 Aachen

Prof.Dr. Alexei P. Stolboushkin
FDS
Room 555
555 Twin Dolphin Drive

Redwood City, CA 94065
USA

Prof.Dr. Jouko Väänänen
Dept. of Mathematics
University of Helsinki
P.O. Box 4

SF-00014 Helsinki

Prof.Dr. Mikhail A. Taitslin
Dept. of Computer Sciences
Tver State University
33, ul. Zhelyabova

Tver 170 000
RUSSIA

Prof.Dr. Moshe Vardi
Dept. of Computer Sciences
Rice University
HB 352, Mail Stop 132
6100 S. Main Street

Houston, TX 77005-1892
USA

Prof.Dr. Simon Thomas
Dept. of Mathematics
Rutgers University
Busch Campus, Hill Center

New Brunswick, NJ 08903
USA

Prof.Dr. Scott Weinstein
Dept. of Philosophy
University of Pennsylvania
Suite 460
3440 Market Street

Philadelphia, PA 19104-3325
USA

Dr. Thomas Wilke
Institut für Informatik und
Praktische Mathematik, Haus I
Universität Kiel

24098 Kiel

Prof.Dr. Martin Ziegler
Institut für Math.Logik und
Grundlagen der Mathematik
Universität Freiburg
Eckerstr. 1

79104 Freiburg