

Journées Complexité et Modèles Finis

Marseille - 25 et 26 mai 2010

Mardi 25 Mai

10h : Accueil autour d'un café.

10h30-11h : FLORENT MADELAINE - *On the containment of forbidden patterns problems.*

11h-11h30 : JOHANNES SCHMIDT - *Complexity classifications for propositional abduction.*

11h30-12h : OLIVIER GAUWIN - *Efficient Enumeration for conjunctive queries over X-underbar structures.*

12h : Déjeuner au CROUS.

14h-15h : VICTOR DALMAU - *The few subpowers property and its application in constraint satisfaction.*

15h : Pause café

15h30-16h : MICHEL DE ROUGEMONT - *Dyck languages in the Streaming model.*

16h-16h30 : DIETRICH KUSKE - *The isomorphism problem for automatic structures.*

16h30-17h : MATHIEU TRACOL - *Approximation de grands systèmes probabilistes par des protocoles de population ordonnés.*

20h : Dîner aux Arcenaux

Mercredi 26 Mai

9h30-10h30 : BENJAMIN ROSSMAN - *Combining Strategies in Ehrenfeucht-Fraïssé Games.*

10h30 : Pause café

11h-11h30 : LUC SÉGOUFIN - *Automata based verification over linearly ordered data domains.*

11h30-12h : DIEGO FIGUEIRA - *Extended register automata on data words and trees.*

12h-12h30 : THOMAS PLACE - *Deciding definability in $FO_2(<_h, <_v)$.*

12h30 : Déjeuner au CROUS.

14h30-15h : GAÉTAN RICHARD - *Logic, picture language and cellular automata.*

15h-15h30 : EMMANUEL JEANDEL - *Periods in tilings and descriptive complexity.*

15h30-16h : VICTOR POUPET - *Complexity classes of language recognition on cellular automata: comparison with the Turing case.*

16h : Clôture des journées

Liste des participants

RÉGIS BARBANCHON - LIF - regis.barbanchon@lif.univ-mrs.fr
JOHANN BRAULT-BARON - GREYC - jbraultb@info.unicaen.fr
PHUONG-THAO CAO - LRI - phuong-thao.cao@lri.fr
NADIA CREIGNOU - LIF - nadia.creignou@lif.univ-mrs.fr
VICTOR DALMAU - UPF - vdalmau@gmail.com
MICHEL DE ROUGEMONT - LRI - Michel.De-Rougemont@lri.fr
ARNAUD DURAND - ELM - durand@logique.jussieu.fr
DIEGO FIGUEIRA - LSV - figueira@lsv.ens-cachan.fr
EMMANUEL FILIOT - ULB - efiliot@gmail.com
OLIVIER GAUWIN - Mons - olivier.gauwin@umons.ac.be
ETIENNE GRANDJEAN - GREYC - Etienne.Grandjean@info.unicaen.fr
DAVID GROSS-AMBLARD - Dijon - david.gross-amblard@u-bourgogne.fr
EMMANUEL JEANDEL - LIF - emmanuel.jeandel@lif.univ-mrs.fr
CHRISTIAN KONRAD - LRI - konrad@lri.fr
DIETRICH KUSKE - LABRI - kuske@labri.fr
RICHARD LASSAIGNE - ELM - lassaigue@logique.jussieu.fr
BARNABY MARTIN - Durham - barnabymartin@gmail.com
FLORENT MADELAINE - LLAIC - florent.madelaine@u-clermont1.fr
ANTOINE-MBAYE NDIONE - LIFL - antoine.ndione@inria.fr
FRÉDÉRIC OLIVE - LIF - frederic.olive@lif.univ-mrs.fr
THOMAS PLACE - LSV - place@lsv.ens-cachan.fr
VICTOR POUPET - LIF - victor.poupet@lif.univ-mrs.fr
SOLOMAMPIONONA RANAIVOSON - GREYC - ionona@info.unicaen.fr
PIERRE-ALAIN REYNIER - LIF - pierre-alain.reynier@lif.univ-mrs.fr
GAÉTAN RICHARD - GREYC - gaetan.richard@info.unicaen.fr
BENJAMIN ROSSMAN - MIT - brossman@mit.edu
ETIENNE SANCHEZ - LRI - Etienne0107@aol.com
JOHANNES SCHMIDT - LIF - johannes.schmidt@lif.univ-mrs.fr
LUC SÉGOUFIN - LSV - luc.segoufin@inria.fr
FRÉDÉRIC SERVAIS - ULB - frederic.servais@gmail.com
MATHIEU TRACOL - LRI - mathieu_tracol@hotmail.fr
PASCAL VANIER - LIF - pascal.vanier@lif.univ-mrs.fr
XAVIER ZEITOUN - LRI - Xavier.Zeitoun@lri.fr

Résumés des interventions

VICTOR DALMAU - *The few subpowers property and its application in constraint satisfaction.*

If B is a relational structure then the non uniform constraint satisfaction problem with template B , $CSP(B)$, is the problem that consists in deciding whether a given relational structure A (the input) is homomorphic to B . The Feder-Vardi conjecture, stating that for every finite B , $CSP(B)$ is in P or NP -complete has motivated a lot of research in the area. The so-called "algebraic" approach to the CSP is based on the study of an algebra that is naturally associated to a template. During this talk we shall review one of the properties of the algebra, namely the few subpowers property, that has played an important role in the identification of tractable subcases of the problem.

MICHEL DE ROUGEMONT - *Dyck languages in the Streaming model.*

I'll present Magniez, Mathieu, Nayak's results (Stoc 2010) which give upper and lower bounds to recognize parenthesis languages. They prove a \sqrt{n} lower bound on the space required to recognize a well formed Dyck word from left to right, using Communication Complexity. They give an algorithm which uses $(\log n)^2$ space if two passes are allowed, from each side. I'll discuss potential applications to decide the validity of XML streams.

DIEGO FIGUEIRA - *Extended register automata on data words and trees.*

We discuss models of alternating automata over words or trees with data that can only move forward, and have one register to store and compare data. We focus in the emptiness problem for these models. In the case of data words, Demri and Lazic showed that the emptiness problem for this automata model is decidable with non primitive recursive complexity. This decidability was extended to data trees by Lazic and Jurdzinski. In this talk we give a simplified proof of decidability for these models, and we show some decidable extensions. These extensions allow to prove decidability of the satisfiability problem for some logics. On data words, we show that LTL with one register and quantification over data values is decidable. And on data trees, we show decidability of 'forward XPath' : a fragment of XPath with downward and rightward navigation.

OLIVIER GAUWIN - *Efficient Enumeration for conjunctive queries over X-underbar structures.*

We investigate efficient enumeration algorithms for conjunctive queries for databases over binary relations that satisfy the X-underbar property. Tree-like relations such as XPath axes or grids are natural examples of such relations. We first show that the result of an n -ary conjunctive query Q over an X-underbar structure S

can be enumerated with a delay in $O(n \cdot |S| \cdot |Q|)$ between two consecutive n -tuples. Then, we consider acyclic conjunctive queries and show that such queries admit an enumeration algorithm with delay $O(|Q| \cdot |D|)$ and a preprocessing in $O(|Q| \cdot |S|)$ where D is the domain of S . The delay can even be improved to $O(n \cdot |D|)$ with a slightly more expensive preprocessing step. As an application of our method, we also show that any n -ary XPath acyclic conjunctive query Q over an unranked tree t can be enumerated with a preprocessing and delay $O(|Q| \cdot |t|)$. We also consider conjunctive queries with possible inequalities between variables. In this case, we show that query evaluation is NP-hard and, unless $P = NP$, these queries do not admit enumeration algorithms with a combined polynomial time delay. However, we also show that hardness relies only on the number l of variables that appear in inequalities. We propose efficient enumeration procedures for acyclic and general conjunctive queries whose delay is exponential in l but polynomial (even quasi-linear) in $|Q|$ and $|S|$.

EMMANUEL JEANDEL - *Periods in tilings and descriptive complexity.*

Tilings are a simple and powerful computational model given entirely by local geometric constraints. In this talk we give a characterization of the set of periods a tiling system may have via complexity classes, à la Selman-Jones.

DIETRICH KUSKE - *The isomorphism problem for automatic structures.*

The general isomorphism problem of automatic structures is known to be highly undecidable (more precisely : complete for the first level of the arithmetical hierarchy and therefore as complicated as possible). The proof of this and similar results indicated that transitive relations give rise to a decidable isomorphism problem. This hope is confirmed by the decidability of the isomorphism problem for ordinals and for Boolean algebras. The talk considers more transitive classes of relations and investigates this problem in particular for automatic equivalence structures, trees of bounded height, trees of finite height, and linear orders. It presents results that were obtained in joint work with Markus Lohrey and Jiamu Liu (Leipzig).

FLORENT MADELAINE - *On the containment of forbidden patterns problems.*

Forbidden patterns problems are a generalisation of (finite) constraint satisfaction problems which are definable in Feder and Vardi's logic MMSNP. In fact, they are examples of infinite constraint satisfaction problems with nice model theoretic properties introduced by Bodirsky. In previous work, we introduced a normal form for these forbidden patterns problems which allowed us to provide an effective characterisation of when a problem is a finite or infinite constraint satisfaction problem. One of the central concept of this normal form is that of a recolouring. In the presence of a recolouring from a forbidden patterns problem Ω_1 to another

forbidden pattern problem Ω_2 , containment of Ω_1 in Ω_2 follows. The converse does not hold in general and it remained open whether it did in the case of problems being given in our normal form. In this talk, we prove that this is indeed the case. We also show that the recolouring problem is Π_2 -hard and in Σ_3 .

THOMAS PLACE - *Deciding definability in $FO_2(<_h, <_v)$.*

I will present a decidable characterization for the tree languages definable in $FO_2(<_h, <_v)$, the first-order logic using only two variables and predicates for the ancestor relation and the following sibling relation.

VICTOR POUPET - *Complexity classes of language recognition on cellular automata: comparison with the Turing case.*

Padding techniques are a well known method to obtain transfer theorems on complexity classes (one inclusion implies another). In this talk we will show how such techniques can be applied to one-dimensional cellular automata and prove a transfer theorem on cellular complexity classes. Then we will discuss the consequences of this result, in particular when linked to the deterministic Turing complexity classes.

GAÉTAN RICHARD - *Logic, picture language and cellular automata.*

La classe des langages d'images reconnaissables en temps linéaire non déterministe sur automate cellulaire est logiquement caractérisée par un fragment du second ordre existentiel. Nous explicitons cette caractérisation, étudions la robustesse de la logique concernée et détaillons ses liens avec la notion de langages d'images reconnaissables telle qu'introduite par Giammarresi *et al.*

BENJAMIN ROSSMAN - *Combining Strategies in Ehrenfeucht-Fraïssé Games.*

Ehrenfeucht-Fraïssé games are a technique for proving inexpressibility results in first-order logic. Games and strategies can be combined and decomposed in various ways. These include projection onto subgames, structural operations (Feferman-Vaught), composition, and blending methods. In this way, a few basic games (on long paths, set-powerset structures, random graphs, etc.) can serve as building blocks for strategies in more complicated games. Applications include results on the expressive power of successor-invariant first-order logic and bounded-variable fragments of first-order logic.

JOHANNES SCHMIDT - *Complexity classifications for propositional abduction.*

Abduction is a fundamental and important form of non-monotonic reasoning. Given a knowledge base explaining how the world behaves it aims at finding an explanation for some observed manifestation. We will concentrate on propositional

nal abduction, where the knowledge base and the manifestation are represented by propositional formulae. The problem of deciding whether there exists an explanation is known to be Σ_P^2 -complete in general. We will discuss the complexity of propositional abduction when formulae are restricted to use connectives from a certain set of Boolean functions only. We will present a complexity classification for all considerable sets of Boolean functions. Further, we will address the problem of counting the explanations and draw a complete picture for the counting complexity.

LUC SÉGOUFIN - *Automata based verification over linearly ordered data domains.*

In this talk we consider linearly ordered data domains equipped with finitely many unary predicates and constants. We consider nondeterministic automata processing words and storing finitely many variables ranging over the domain. During a transition, these automata can compare the data values of the current configuration with those of the previous configuration using the linear order, the unary predicates and the constants. We show that emptiness for such automata is decidable, both over finite and infinite words, under reasonable computability assumptions on the linear order. Finally, we show how our automata model can be used for verifying properties of workflow specifications in the presence of an underlying database.

MATHIEU TRACOL - *Approximation de grands systèmes probabilistes par des protocoles de population ordonnés.*

On considère des réseaux de Processus de Décision Markoviens (MDPs) où chaque MDP est sur l'un des noeuds d'un graphe G , et dont les probabilités de transitions dépendent de son environnement, i.e. des états de ses voisins. L'ensemble des configurations d'un tel système est de taille exponentielle en le nombre de noeuds, et les méthodes d'analyse classiques ne sont pas applicables. On propose un modèle de Protocole de Population Partiellement Ordonné pour approximer un tel système, ayant pour ensemble d'états les statistiques du système original. Le fait que ces statistiques soient en nombre polynomial permet d'obtenir des systèmes d'approximation de petites tailles sur lesquels on peut évaluer des propriétés.