# Abstracts of talks presented at INFINITY 2018

## Invited talks

- Jérôme Leroux: Ideal Decompositions: Applications to Petri Net Extensions.

  We present extensions of Petri nets that are well-structured and therefore allow generic decision procedures for several verification problems. By inspecting the data structures of classical algorithms for Petri nets, we show that they can be interpreted as ideals for well quasi ordered sets. This new interpretation of classical data structures paves the way to extend algorithms to various Petri net extensions. In this presentation we mainly focus on the framework of ideal decompositions for well-quasi-ordered sets with Petri nets extensions as running examples.

- Sylvain Schmitz: On the Complexity of VAS Reachability.

  The decidability of the reachability problem in vector addition systems is a landmark result in theoretical computer science, with applications in an array of fields ranging from program verification to data logics. I will present the main arguments of the first known complexity upper bound for this problem, obtained together with Leroux by analysing the decomposition algorithms invented by Mayr and successively refined by Kosaraju and Lambert.

## Contributed talks

- Lorenzo Clemente: Decidability of Timed Communicating Automata.

  We study the reachability problem for networks of timed communicating processes. Each process is a timed automaton communicating with other processes by exchanging messages over unbounded FIFO channels. Messages carry clocks which are checked at the time of transmission and reception with suitable timing constraints. Each automaton can only access its set of local clocks and message clocks of sent/received messages. Time is dense and all clocks evolve at the same rate. We show a complete characterisation of decidable and undecidable communication topologies generalising and unifying previous work. From a technical point of view, we use quantifier elimination, and a reduction to counter automata with registers.

- Wojciech Czerwiński: Example of a VASS with Doubly Exponential Shortest Run in a Fixed Dimension.

  I will present an example of four dimensional Vector Addition System with States, for which the shortest path from source configuration to target configuration is doubly exponential w.r.t. the number of states and binary representation of numbers in transitions. This result is based on a number theory lemma, which may be interested in its own and potentially useful for creating hard examples in other infinite state systems. Informally speaking lemma says that it is possible to find a small set of fractions bigger than 1 with moderate size both numerator and denominator such that multiplication of quite big powers of these fractions is still a fraction with moderate size numerator and denominator.

- Piotr Hofman: Around State Equation.

  The better analysis of infinite-state transition systems is impossible without the development of new heuristics. In this talk, I want to focus on extensions of an old and well-known result about state equation for Petri nets. For a given Petri Net $N = (P, T, Pre, Post)$ (places, transitions, pre matrix, post matrix) and two markings $I$ and $F$ holds the following fact: If there is no solution in natural numbers for the equation $F - I = (Post - Pre)x$ then it is impossible to reach $F$ from $I$ in the net $N$. In particular, I will cover recent development in Petri Nets with data.

- Sławomir Lasota: Regular Separability of Well-Structured Transition Systems.

  We investigate the languages recognized by well-structured transition systems (WSTS) with upward and downward compatibility. Our first result shows that, under very mild assumptions, every two disjoint WSTS languages are regular separable: There is a regular language containing one of them and being disjoint from the other. As a consequence, if a language as well as its complement are both recognized by WSTS, then they are necessarily regular. In particular, no subclass of WSTS languages beyond the regular languages is closed under complement. Our second result shows that, for the case of Petri nets, the complexity of the backwards coverability algorithm yields a bound on the size of the regular separator. We complement it by a lower bound construction.

- Ranko Lazić: The Reachability Problem for Unary Linear Path Schemes.

  An important class of vector addition systems are those that are flat, i.e. that are unions of linear path schemes. Although it is straightforward to see that the reachability problem for succinct linear paths schemes is NP-complete, the conjecture that it is NL-complete for unary linear path schemes in any dimension which is at least two remains open. Initial progress was made by Englert et al. (LICS 2016) who proved it for dimension two. After stating some slightly stronger conjectures for dimensions three onwards, I shall present a few surprising counter-examples that disprove them.

- Filip Mazowiecki: Affine Extensions of Integer Vector Addition Systems with States.

  We study the reachability problem for affine Z-VASS, which are integer vector addition systems with states in which transitions perform affine transformations on the counters. This problem is easily seen to be undecidable in general, and we therefore restrict ourselves to affine Z-VASS with the finite-monoid property (afmp-Z-VASS). The latter have the property that the monoid generated by the matrices appearing in their affine transformations is finite. The class of afmp-Z-VASS encompasses classical operations of counter machines such as resets, permutations, transfers and copies. We show that reachability in an afmp-Z-VASS reduces to reachability in a Z-VASS whose control-states grow polynomially in the size of the matrix monoid. Our construction shows that reachability relations of afmp-Z-VASS are semilinear, and in particular enables us to show that reachability in Z-VASS with transfers and Z-VASS with copies is PSPACE-complete.

- Alexander Rabinovich: Reachability Problem for Nets over Register Automata.

  We consider nets of Kaminsky-Frances register automata over unordered channels. We prove that the control reachability problem is decidable. Our proof is based on an instantiation of the well-structured transition system framework.

- Dominik Velan: Efficient Algorithms for Asymptotic Bounds on Termination Time in VASS.

  Vector Addition Systems with States (VASS) provide a well-known and fundamental model for the analysis of concurrent processes, parametrized systems, and are also used as abstract models of programs in resource bound analysis. We study the problem of obtaining asymptotic bounds on the termination time of a given VASS. In particular, we focus on the practically important case of obtaining polynomial bounds on termination time. First, we present a characterization for VASS with linear asymptotic complexity. We also show that if a complexity of a VASS is not linear, it is at least quadratic. Second, we classify VASS according to quantitative properties of their cycles. We show that certain singularities in these properties are the key reason for their non-polynomial asymptotic complexity. In absence of singularities, we show that the asymptotic complexity is always polynomial and of the form $\Theta(n^k)$, for some integer $k \leq d$. We present a polynomial-time algorithm computing the integer k. The results are based on new insights into the geometry of VASS dynamics, which hold the potential for further applicability to VASS analysis.