INVITED SPEAKERS : LIST OF ABSTRACTS

Jason Bell (University of Waterloo, Canada)

Automatic sets and additive bases.
A subset S of the natural numbers is an additive basis if there is number r such that every natural number can be expressed as the sum of at most r elements from S; it is an asymptotic additive basis if every sufficiently large natural number can be expressed as a sum of at most r elements from S. An example of an additive basis, is the set of perfect squares, since every natural number is a sum of at most four squares. We give necessary and sufficient conditions for a k-automatic set to be an additive basis (respectively an asymptotic additive basis) and show how, when it has this property, one can determine the smallest natural number r such that every natural number (respectively every sufficiently large natural number) can be expressed as a sum of at most r elements from the set. This is joint work with Jeff Shallit and Kathryn Hare.

Emilie Charlier (University of Liège, Belgium)

Nyldon words.
The theorem of Chen-Fox-Lyndon states that every finite word w over a fixed alphabet A can be uniquely factorized as $w = l_1 \cdots l_k$, where $(l_1, \ldots, l_k)$ is a nonincreasing sequence of Lyndon words with respect to the lexicographic order. This theorem can be used to define the family of Lyndon words over A in a recursive way: 1) the letters are Lyndon; 2) a finite word of length greater than one is Lyndon if it cannot be factorized into a nonincreasing sequence of shorter Lyndon words. In a post on Mathoverflow in November 2014, Darij Grinberg defines a variant of Lyndon words, which he calls Nyldon words, by reversing the lexicographic order in the previous recursive definition. The class of words so obtained is not, as one might first think, the class of maximal words in their conjugacy classes. Gringberg asks three questions: 1) How many Nyldon words of length n are there? 2) Is there an equivalent to the Chen-Fox-Lyndon theorem for Nyldon words? 3) Is it true that every primitive words admits exactly one Nyldon word in his conjugacy class? In this talk, I will discuss these questions in the more general context of Lazard factorizations of the free monoid and show that each of Grinberg's questions has an explicit answer. This is a joint work with Manon Philibert (ENS Lyon) and Manon Stipulanti (ULiège).

Michael Coons (University of Newcastle, Australia)

Automatic sequences and Mahler's measure.
In this talk, we relate the Mahler measure of height-one polynomials to certain uniform morphisms. In particular, we will show that the Mahler measure of every height-one polynomial can be expressed as the maximal Lyapunov exponent of a matrix cocycle that arises in the spectral theory of 2-automatic sequences. In this way, one comes up with a sort of dynamical analogue of Lehmer's problem on

minimal Mahler measures. This is joint work with Michael Baake and Neil Manibo (University of Bielefeld, Germany).

Gabriele Fici (University of Palermo, Italy)

Anti-powers in words: a new notion of regularity based on diversity.
In combinatorics of words, a concatenation of k consecutive equal blocks (factors) is called a power of order k. In this talk we present a different point of view and define an anti-power of order k as a concatenation of k consecutive pairwise distinct blocks of the same length. We show that every infinite word must contain powers of any order or anti-powers of any order. We also discuss some other questions related to the definition of anti-power.In collaboration with A. Restivo, M. Silva and L. Zamboni.

Anna Frid (Aix-Marseille University, France)

Ostrowski numeration and palindromes in Sturmian words.
We describe palindromes in Sturmian words in terms of Ostrowski representations of their ends. In particular, this allows to prove for all Sturmian words the existence of a prefix of any given palindromic length. The particular case of the Fibonacci word is also considered in detail.

Stepan Holub (Charles University, Czech Republic)

Algebraic approach to word equations.
We shall explain how to encode word equations into vectors of polynomials. In some specific situations this approach allows to obtain nontrivial information about equations. We shall also discuss difficulties that hinder the use of this method in a more general setting.

Sébastien Labbé (University of Bordeaux, France)

On Jeandel-Rao aperiodic tilings.
In 2015, Jeandel and Rao showed by exhaustive computer search that every Wang tile set of cardinality ≤ 10 either (1) admit a periodic tiling of the plane or (2) admit no tiling of the plane at all. Moreover, they found a Wang tile set of cardinality 11 which admits tilings of the plane but never periodically. In this talk, we present an alternative definition of the aperiodic tilings of Jeandel-Rao as the coding of a $\mathbb{Z}^2$-action on the torus. We conjecture that it is a complete characterization.

Jarkko Peltomaki (University of Turku, Finlande)

Abelian Powers and Repetitions in Sturmian Words.
In [1], I studied with G. Fici et al. abelian powers and repetitions in Sturmian words. An abelian power is a power where permutation of letters is allowed, and abelian repetitions generalize the usual notion of a period to the abelian setting. We showed how to compute the maximum exponent of an abelian power of a given abelian period in a Sturmian word of slope α, and it turns out that this exponent is always bounded. However, by increasing the abelian period, the exponent can always be made arbitrarily large. In essence, we showed that if the abelian period corresponds to a denominator of a convergent of α, then the exponent is exceptionally high. Our proof methods rely heavily on properties of continued fractions, and our work

is a good example of powerful interplay between arithmetic and combinatorics. As the exponent of an abelian power can be arbitrarily large, we define a new notion of abelian critical exponent, which measures the maximum ratio between the exponent and the period of an abelian power. One of our main results is that this quantity, which is natural from the word-combinatorial perspective, coincides with the Lagrange constant of the slope α, which is a number-theoretic notion. As a consequence, we show that the abelian critical exponent is finite if and only if α has bounded partial quotients. We also study abelian periods of factors of Sturmian words and show that the minimum abelian period of a factor of the Fibonacci word is always a Fibonacci number. In the talk, I will talk about the results mentioned above and show the key insights in their proofs.

Dominique Perrin (University of Marne la Vallée, France)

Free profinite monoids.
The free profinite monoid is the completion of the free monoid for a distance using the size of an automaton separating two words. It allows to formulate some results on minimal subshifts, especially in their relation with morphisms on finite groups. I will present some of these results.

Narad Rampersad (University of Winnipeg, Canada)

Critical exponent of balanced words.
Over a binary alphabet it is well-known that the aperiodic balanced words are exactly the Sturmian words. The repetitions in Sturmian words are well-understood. In particular, there is a formula for the critical exponent (supremum of exponents e such that x^e is a factor for some word x) of a Sturmian word. It is known that the Fibonacci word has the least critical exponent over all Sturmian words and this value is $(5+\sqrt{5})/2$. However, little is known about the critical exponents of balanced words over larger alphabets. We show that the least critical exponent among ternary balanced words is $2+\sqrt{2}/2$ and we construct a balanced word over a four-letter alphabet with critical exponent $(5+\sqrt{5})/4$. This is joint work with J. Shallit and E. Vandomme.

Michel Rigo (University of Liège, Belgium)

Games and multidimensional shape-symmetric morphism.
The general motivation behind this talk is to present some interplay between combinatorial game theory and combinatorics on multidimensional words.

We do not assume that the participants have any prior knowledge in CGT. Thus, we will present some basic concepts from combinatorial game theory (positions of a game, Nim-sum, Sprague-Grundy function, Wythoff's game, ...). We will see that games provide examples of k-automatic, morphic or k-regular sequences (in the sense of Allouche and Shallit). Subtraction games played on several piles of token naturally give rise to a multidimensional setting. Thus, we consider k-automatic and k-regular sequences in this extended framework. In particular, determining the structure of the bidimensional array encoding the (loosing) P-positions of the Wythoff's game is a long-standing and challenging problem in CGT. Wythoff's game is linked to non-standard numeration system: P-positions can be determined by writing those in the Fibonacci system. The main part of this talk is to discuss the concept of shape-symmetric morphism introduced by Maes: instead of iterating a morphism where images of letters are (hyper-)cubes of a fixed length k, one can generalize the procedure to images of various shape. We will present several decision problems which are decidable thanks to automata.

Jeffrey Shallit (University of Waterloo, Canada)

Additive number theory and automata.
The principal problem of additive number theory is to decide, given a set S of natural numbers, whether every natural number (resp. every sufficiently large number) can be written as the sum of k elements of S, for some finite k. As examples we recall the classical theorem of Lagrange – every natural number is the sum of 4 squares, and the still unresolved Golbach conjecture: whether every even integer ≥ 4 is the sum of two primes. In this talk I will discuss how to solve problems in additive number theory without using any number theory at all! Among other things, we prove that:

(a) Every natural number is the sum of at most 4 binary palindromes (natural numbers whose canonical base-2 expansion is a palindrome).

(b) Every natural number > 686 is the sum of at most 4 natural numbers whose canonical base-2 representation is a binary square.

This is joint work with Aayush Rajasekaran, Tim Smith, Dirk Nowotka, Parthasarathy Madhusudan, Jason Bell, and Kathryn Hare.

Arseny Shur (Ural Federal University,Russia)

On factor complexity of power-free words. Power-free words and factor complexity are two quite popular topics in Combinatorics of words; however, they surprisingly rare meet each other. In this talk we present some results and formulate a few conjectures about minimal and maximal possible factor complexity for words avoiding certain powers. In particular, we show that among the binary overlap-free words there is a word of smallest complexity $c(n)$ and a word of biggest complexity $C(n)$ such that for an arbitrary overlap-free word its complexity $f(n)$ satisfies $c(n) \leq f(n) \leq C(n)$ for all n. The talk is based on a joint work with J. Shallit.

Reem Yassawi (Trent University, Canada)

Recognizability for sequences of morphisms. We investigate different notions of recognizability for a free monoid morphism $\sigma : \mathcal{A}^* \to \mathcal{B}^*$. Full recognizability occurs when each (aperiodic) point in $\mathcal{B}^{\mathbb{Z}}$ admits at most one tiling with words $\sigma(a)$, $a \in \mathcal{A}$. This is stronger than the classical notion of recognizability of a substitution $\sigma : \mathcal{A}^* \to \mathcal{A}^*$, where the tiling must be compatible with the language of the substitution. We show that if $|\mathcal{A}| = 2$, or if σ's incidence matrix has rank $|\mathcal{A}|$, or if σ is permutative, then σ is fully recognizable.

Next we define recognizability and also eventual recognizability for sequences of morphisms which define an S-adic shift. We prove that a sequence of morphisms on alphabets of bounded size, such that compositions of consecutive morphisms are growing on all letters, is eventually recognizable for aperiodic points. We provide examples of eventually recognizable, but not recognizable, sequences of morphisms, and sequences of morphisms which are not eventually recognizable. As an application, for a recognizable sequence of morphisms, we obtain an almost everywhere bijective correspondence between the S-adic shift it generates, and the measurable

Bratteli-Vershik dynamical system that it defines; equivalently, we show that the S-adic shift defined by a recognizable sequence of morphisms is measurably conjugate to a measure preserving dynamical system on a Lebesgue space.

This is joint work with Valérie Berthé, Wolfgang Steiner and Jörg Thuswaldner.

References

[1] G. Fici, A. Langiu, T. Lecroq, A. Lefebvre, F. Mignosi, J. Peltomäki, É. Prieur-Gaston. Abelian powers and repetitions in Sturmian words. *Theor. Comput. Sci.* **635** (2016), 16–34.