Josiah Aakre (University of Manchester)

Wednesday 2 July, 12:03–12:12 • Room 103

Short Communications V

Simplicity of algebras associated to self-similar groupoids

Self-similar groupoids are a recent generalization of the well-known self-similar groups of Nekrashevych. Let $\Gamma = (\Gamma^0, \Gamma^1, s, r)$ be a finite directed graph and let G be a groupoid with a self-similar action on the set of finite paths Γ^*. There is an étale (and often non-Hausdorff) groupoid associated to the self-similar action of G which may be viewed as the tight groupoid of a natural inverse semigroup associated to G. We take the inverse semigroup approach to study certain algebras associated to this étale groupoid.

In particular, we extend (to the contracting self-similar groupoid case) the algorithm of Steinberg and Szakács which takes as input the nucleus of a contracting group and outputs all characteristics of fields over which the Steinberg algebra of the associated étale groupoid is simple. We apply recent results of Brix, Gonzales, Hume, and Li to the context of contracting self-similar groupoids to show that the reduced C*-algebra of the associated étale groupoid is simple if and only if the Steinberg algebra is simple.

For a covering graph Δ of Γ, we derive a self-similar groupoid C from G which acts on the path set of Δ, and we discuss when the simplicity of algebras associated to the 'covering groupoid' C is dependent on the simiplicity of algebras associated to G.

Antoine Abram (UQAM)

Tuesday 1 July, 11:00–11:09 • Room 110

Short Communications III

The stylic monoid

The free monoid A^* on a finite totally ordered alphabet A acts on columns from the left via Schensted's left insertion. This defines a finite monoid called the stylic monoid, which is a quotient of the plactic monoid by the relation $a^2 = a$ for all $a \in A$. We establish a bijection with so-called N-tableaux, analogous to Schensted's algorithm. Using this set of representatives and the insertion algorithm, we derive interesting properties of the monoid, such as its cardinality being the number of partitions of a set with $|A| + 1$ elements, its being J-trivial, and its J-order being graded.

Azeef Ajmal (Western Sydney University)

Wednesday 2 July, 12:03–12:12 • Room 110

Short Communications VII

Left reductive regular semigroups

Cayley's theorem states that any group G can be faithfully represented as a permutation group on the set G. A semigroup S can be similarly represented as a transformation semigroup on the set S. This representation is not always faithful, but when it is, the semigroup is called left reductive. In this talk, we develop the ideal structure theory for the class of left reductive regular semigroups using certain small categories, and apply it to several subclasses of popular interest. This is a recent joint work with Gracinda Gomes.

Jorge Almeida (Universidade do Porto)

Monday 30 June, 11:00–12:30 • Room 106

Thematic Session: New models of formal language recognition

New models of formal language recognition

The syntactic approach to the classification of regular languages is a well-known success story. The general key ingredients are Eilenberg's correspondence, providing an algebraic translation of problems on regular languages through their (ordered) syntactic semigroups, and Birkhoff-type theorems, describing pseudovarieties of such structures. The theory carries over to other combinatorial algebraic contexts, with ample motivation from computer science in the case of tree languages.

Mainly with the aim of separating various classes of languages, several attempts have been made to extend this theory beyond regular languages. Fixing the alphabet, most often we are interested in Boolean algebras, or at least lattices of languages, which leads to the consideration of their dual (Stone, respectively Priestley) spaces. In the case of regular word languages, this leads to profinite semigroups, which have been instrumental in the solution of many problems.

The session will consist of the following two talks:

1. Stone recognition of languages

The purpose of this talk is to present the general framework for the recognition of Boolean algebras and lattices of subsets of topological algebras (typically, a discrete relatively free algebra) by Stone topological algebras by characterizing those classes of languages that can be so recognized. The results can be simply formulated as an equivalence of categories.

2. How to use Stone recognition for arbitrary word languages

We first provide an Eilenberg-type correspondence for Stone recognition. We then show how the minimal automaton of an arbitrary word language can be naturally completed into a Stone topological unary algebra. We also deduce a general criterion for separation of suitable language classes and exemplify how it applies for certain classes of context-free languages.

(Both based on joint work with O. Klíma)

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Marina Anagnostopoulou-Merkouri (University of Bristol)

Monday 30 June, 14:00–14:30 • Room 103

Thematic Session: Groups 1

Permutation groups, partition lattices and block structures

Let $G \leq Sym(\Omega)$ be a finite transitive permutation group. We say that G is primitive if it preserves no nontrivial partition of Ω, and imprimitive otherwise. Primitive groups have been heavily studied by group theorists over the years. Not as much is known on the other hand about imprimitive groups and there is generally no sensible way to describe their structure in detail. However, those groups are very interesting to study from a combinatorial angle. In particular, it can be very fruitful to explore the lattice of their invariant partitions. In this talk we will present some recent work on imprimitive groups whose lattices of partitions form special combinatorial structures called orthogonal and poset block structures, which are widely used by statisticians in the design of experiments.

This is joint work with Rosemary Bailey and Peter Cameron.

Jessica Anzanello (University of Milano-Bicocca)

Tuesday 1 July, 11:09–11:18 • Room 106

Short Communications II

On the Chebotarev invariant of a finite group

A subset $\{g_1, \ldots, g_t\}$ of a finite group G *invariably generates* G if $\{g_1^{x_1}, \ldots, g_t^{x_t}\}$ generates G for every t-tuple $(x_1, \ldots, x_t) \in G^t$. In this talk, I will address the following questions. Let G be a finite group. If we choose random elements from G independently, with replacement, and with the uniform distribution, how many should we expect to pick until the elements chosen generate G? And how many to invariably generate G?

To discuss the latter, I will introduce an invariant that is related to problems in Galois theory, called the *Chebotarev invariant $C(G)$ of G, which is the expected value of the stopping time T that is the minimal integer such that T randomly chosen elements of G invariably generate G. I will focus on recent joint work with Andrea Lucchini and Gareth Tracey providing estimates for $C(G)$ in the case of finite simple groups and, more generally, for direct products of non-abelian finite simple groups.*

Reference:

"The Chebotarev invariant for direct products of nonabelian finite simple groups" (J. Anzanello, A. Lucchini, and G. Tracey), to appear in Proc. Am. Math. Soc. (2025).

João Araújo *(NOVA University of Lisbon)*

Thursday 3 July, 11:30–12:00 • Room 122

Thematic Session: Automated Reasoning and the Future of Mathematical Practice

An Overview of ProverX: Capabilities and Achievements

ProverX is a flexible system for automated reasoning, whose kernel integrates both theorem provers and finite model builders. On top of this core, ProverX supports a modular architecture that allows the addition of specialised packages tailored to particular classes of mathematical problems. In this talk, I will provide a brief overview of the system's structure, capabilities, and some of its most significant successes.

Robert Bailey *(Memorial University of Newfoundland)*

Monday 30 June, 15:30–16:00 • Room 103

Thematic Session: Groups 1

On distance-regular graphs with primitive automorphism groups

A graph is distance-regular if, for each vertex v and each vertex w at distance i from v, the number of neighbours of w at distances $i-1$, i or $i+1$ from v depends only on i, and not on the choice of v or w. These are highly-structured graphs with interesting structural and algebraic properties. Many of the well-known examples have large automorphism groups, and many fascinating groups (including several sporadic simple groups) arise as automorphism groups of such graphs.

An ongoing project is to classify (as far as possible) "small" distance-regular graphs with primitive automorphism groups by making use of the GAP libraries of primitive permutation groups. This in turn has led to some more theoretical questions about graphs arising from certain primitive group actions. In this talk, I will discuss the status of this work, a few surprises which came up along the way, and some (theoretical and computational) questions which remain open.

Rosemary Bailey *(University of St. Andrews)*

Monday 30 June, 12:00–12:30 • Auditorium

Thematic Session: Design of Experiments: Mathematical, Computational and Statistical Aspects

Semi-Latin squares and their extensions

TBA

Callum Barber *(University of St Andrews)*

Tuesday 1 July, 12:03–12:12 • Room 122

Short Communications IV

Congruences and Diagonal Subsemigroups

For a group G it is easy to show that every subgroup of $G \times G$ that contains the diagonal, $\Delta = \{(x,x) : x \in G\}$, is also a congruence on G. However the analogous result for semigroups does not hold in general. We will call a semigroup DSC if every diagonal subsemigroup is a congruence. It is easy to see that any finite group must be DSC, and that any DSC semigroup must be simple. Building on this, we will show that for several broad classes of semigroups that the only DSC members are groups. However it turns out that there does exist non-group DSC semigroups, which we obtain by utilising a construction introduced by Byleen for the purpose of constructing interesting congruence-free semigroups.

Marco Barbieri *(University of Lubljana)*

Tuesday 1 July, 11:45–11:54 • Room 106

Short Communications II

Separating subsets from their images

Let G be a transitive permutation group of degree n, and let A be a subset of points. What is the largest size $\mathbf{m}(G)$ that A can have while still guaranteeing the existence of a permutation $g \in G$ such that $A \cap A^g$ is empty? By Neumann's Separation Lemma, we must have $\mathbf{m}(G) \geq \sqrt{n}$. Experimental evidence suggests that, unless G contains a large alternating section, $\mathbf{m}(G)$ grows asymptotically as $O(\sqrt{n})$. We show that this behavior can be proven via probabilistic methods when G is regular, and we discuss how the general case can be reduced to the study of basic primitive groups.

Serhii Bardyla *(University of Vienna)*

Wednesday 2 July, 11:54–12:03 • Room 122

Short Communications VIII

Topological transformation monoids

We consider the questions of which topological semigroups embed topologically into the full transformation monoid $\mathbb{N}^{\mathbb{N}}$ or the symmetric inverse monoid $I_{\mathbb{N}}$ equipped with their respective canonical Polish semigroup topologies. We characterize those topological semigroups that embed topologically into $\mathbb{N}^{\mathbb{N}}$ and belong to any of the following classes: commutative semigroups; compact semigroups; groups; and certain Clifford semigroups. Analogous characterizations are proven for topological inverse semigroups and $I_{\mathbb{N}}$. We construct several examples of countable Polish topological semigroups that do not embed into $\mathbb{N}^{\mathbb{N}}$, which answer, in the negative, a problem of Elliott, Jonušas, Mesyan, Mitchell, Morayne and Péresse. Also, we classify all Polish semigroup topologies on the symmetric inverse monoid I_N, and show that the monoid I_N endowed with any second countable T_1 semigroup topology is homeomorphic to the Baire space N^N.

Anton Baykalov *(University of Galway)*

Tuesday 1 July, 11:54–12:03 • Room 103

Short Communications I

Computing zeta functions of groups and algebras

In this talk, I will report on ongoing work on explicit computations of zeta functions associated with various types of counting problems attached to groups, algebras, and related algebraic structures. The goal of this project is to combine systematic methods (which can be very computationally involved and limited in scope) and ad hoc approaches driven by human insight.

Stefano Bonzio *(University of Cagliari (Italy))*

Tuesday 1 July, 11:09–11:18 • Room 103

Short Communications I

On the structure and theory of McCarthy algebras

In this talk, we provide an equational basis for McCarthy algebras, the variety generated by the three-element algebra defining the logic of McCarthy (the non-commutative version of Kleene three-valued logics), solving a problem left open by Konikowska. This logic has been applied in computer science to formally model failures in computation, via specific process algebras' formalisms. Differently from Konikowska, we tackle the problem in a more general algebraic setting by introducing McCarthy algebras as a subvariety of unital bands (idempotent monoids) equipped with an involutive (unary) operation ' satisfying $(x')' \approx x$*; herein referred to as i-ubands. Prominent (commutative) subvarieties of i-ubands include Boolean algebras, ortholattices, Kleene algebras, and involutive bisemilattices, hence i-ubands provides an algebraic common ground for several non-classical logics. Beside our main result, we also get a semilattice decomposition theorem for McCarthy algebras and a characterization of the (lowest levels of the) lattice of subvarieties of i-ubands, shedding new light on the connection with Kleene logics.*

David Bradley-Williams *(Computer Science Institute of Charles University, Prague.)*

Tuesday 1 July, 15:00–15:30 • Room 103

Thematic Session: Groups 2

Extending partial automorphisms of graphs.

Even though almost all finite graphs are rigid, it is possible to embed every finite graph into a significantly more symmetric graph with a rich automorphism group. Namely E. Hrushovski proved in the early 90's that every finite graph G *can be embedded into a finite graph* H *such that every partial automorphism of* G *extends to a full automorphism of* H*. We are interested in how small a graph* H *can be – and in the best cases, what wonderful properties the group* $\mathrm{Aut}(H)$ *has. This talk will include results of joint work with S. Brenner, P. J. Cameron, J. Hubička, and M. Konečný.*

Emmanuel Briand *(Universidad de Sevilla)*

Wednesday 2 July, 11:45–11:54 • Room 103

Short Communications V

Piecewise quasipolynomial functions

Quasipolynomials are functions on $\mathbb{Z}^n$ *given by several polynomials, one for each coset of some full-rank sublattice. The piecewise quasipolynomials we want to present are the functions on* $\mathbb{Z}^n$ *given by several quasipolynomials, on on each maximal cell of a complex of cones subdividing a bigger cone, outside of which the function is 0.*

Examples of such piecewise quasipolynomials are: the vector partition functions, the fiber-counting functions of projections from cones, and several important multiplicity functions in representation theory, such as Kostka, Littlewood-Richardson and Kronecker coefficients.

We want to present in this talk this class of functions, and the ongoing project of a database of piecewise quasipolynomial functions.

Carl-Fredrik Nyberg Brodda *(Korea Institute for Advanced Study)*

Monday 30 June, 11:00–12:30 • Room 110

Thematic Session: Geometric and combinatorial (inverse) semigroup theory 1

An introduction to combinatorial inverse semigroup theory

Combinatorial semigroup theory is an old subject, but its incarnation as applied to inverse semigroups is relatively new. This session will be a gentle introduction to the subject, where I will first go over the main historical developments and the main technical tools behind the subject, including free inverse monoids, Munn trees, presentations of inverse monoids, Stephen's procedure, and many more things. I will also contrast the subject with results from the more matured areas of combinatorial semigroup and group theory, and finish by presenting an overview of some of the recent surprising results that have set the stage for a new chapter in the area.

Carl-Fredrik Nyberg Brodda *(Korea Institute for Advanced Study)*

Thursday 3 July, 14:00–14:30 • Room 110

Thematic Session: Geometric and combinatorial (inverse) semigroup theory 3

The growth of free inverse monoids

*I'll present recent results joint with Kambites, Szakács, and Webb on computing the exact exponential growth rates of non-monogenic free inverse monoids, which turns out to be a very mysterious sequence of algebraic numbers. I'll contrast this with the growth in other free algebraic structures, including that of free regular *-monoids arising in work by East, Muhammed, Gray, and Ruškuc.*

Daniela Bubboloni *(University of Florence (Italy))*

Tuesday 1 July, 11:27–11:36 • Room 106

Short Communications II

Null players in finite groups

A null player in a coalitional game is a player who does not contribute to any coalition it joins. This classic concept is revisited for finite groups, starting from the consideration of the Frattini subgroup, which is immediately recognized as the null player set of the simple game assigning value 1 *to the subsets generating the group and value* 0 *to those not generating it. Many other interesting simple games involving concepts in finite group theory such as commutators, normal generation, determination with respect to the automorphism group, can naturally be considered. In many occasions the corresponding null player sets give rise to interesting normal subgroups, which seem to be ignored in the literature on group theory. The use of the Banzhaf value and the Shapley value, with respect to those games, allows to create a relation of order inside the group and hence to discover various level of capability to generate, to normal generate, to determine and so on. In order to widely apply the machinery of coalitional games to finite groups, we need to introduce new definitions, such as that of reduced game for a family of coalitions and of k-efficiency. In this way we generalize the classic notion of reduced game pointed on a fixed coalition and produce a wide range of possible applications both for the algebraic context and for the game theoretical context.*

Robert Calderbank *(Duke University)*

Monday 30 June, 09:45–10:30 • Auditorium

Plenary Session I

Teaching Old Sequences New Tricks

Periodic sequences with good correlation properties have found many applications in communications and radar systems. Many families of sequences are constructed from quadratic forms over the binary field, an area to which Peter Cameron has made many contributions. Emerging applications to 6G wireless systems require good correlation properties in both delay and Doppler, and this talk will describe how familiar families of sequences are finding new applications.

Peter Cameron *(University of St Andrews)*

Thursday 3 July, 16:30–17:15 • Auditorium

Plenary Session X

SEMPER ABSTRACTA

One of the figures in the magnificent azulejos in the Geometry hall in the University of Evora carries a banner saying "SEMPER ABSTRACTA". This is good advice for mathematicians: the power of our subject rests partly in the fact that our abstract arguments and theorems can be applied to a wide range of concrete situations. However, the advice is a bit problematic. Most mathematicians would regard numerical computation as being discrete, but perhaps algebraic computation is more abstract. Also, graph theory is prob- ably more concrete than algebraic geometry. The borderline is often unclear. I will discuss several topics that have arisen in my own work where the shifting boundary between concrete and abstract *is important. I plan to include graphs with smallest eigenvalue -2; the random graph and Zermelo–Fraenkel set theory; and two ways of looking at Frobenius groups.*

André Carvalho *(University of Porto)*

Thursday 3 July, 12:06–12:28 • Room 110

Thematic Session: Conjugacy and Induced actions in groups, semigroups, and automata

Geodesic languages for rational subsets and conjugates in virtually free groups

In this talk, we will consider rational subsets of virtually free groups and languages of geodesics related to the subset and its set of conjugates. We will sketch the ideas that show that the language of geodesic words representing an element in a rational subset of a virtually free group is regular and that the language of geodesic words representing a conjugate to an element in the subset is context-free. We will also discuss generalizations to the hyperbolic setting. This is joint work with Pedro V. Silva (University of Porto)

Lei Chen *(Bielefeld University)*

Tuesday 1 July, 11:45–11:54 • Room 110

Short Communications III

Finite highly-arc-transitive digraphs

It is shown by Weiss that a finite undirected graph Gamma such that Gamma is not a directed cycle can be at most 7-arc-transitive, making a stark contrast to the situation with finite directed graphs. Praeger proved in 1993 that, for all integers $s \geq 1$ and $s \geq 2$, there exist infinitely many finite digraphs of (out-)valency k that are s-arc-transitive but not $(s+1)$-arc transitive. The problem of characterising infinite digraphs with similar properties has also been studied extensively: an infinite digraph is said to be highly-arc-transitive if it is s-arc transitive for all finite s. It was well known that every directed tree with constant in-and out-valencies is highly-arc-transitive, and Cameron had even speculated as to whether every infinite highly-arc-transitive digraph 'is fairly close to being a tree'.

Returning to finite digraphs, the full automorphism groups of the family of s-arc transitive digraphs constructed in Praeger has the property that each s-arc transitive subgroup G of automorphisms has a nontrivial vertex-intransitive normal subgroup, that is to say, G is not vertex-quasiprimitive. Later in 1995, new construction by Conder, Lorimer and Praeger produced, for each $s \geq 1$ and $k \geq 2$, infinitely many (G, s)-arc-transitive digraphs with out valency k, for which group G is an alternating group and hence is vertex-quasiprimitive (all non-trivial normal subgroups were vertex-transitive). Unfortunately, the automorphism group of the constructed digraph was not determined.

We recently constructed a new infinite family of G-vertex-quasiprimitive s-arc-transitive digraph Gamma such that G is a projective special linear group and s can be arbitrarily large. Though, the full automorphism of Gamma has not been determined, we showed that, after taking a sequence of normal quotients, we will obtain a s-arc-transitive digraph Gamma$'$ such that the automoprhism group of Gamma$'$ is almost simple with socle a projective special linear group.

We also would like to introduce our recent analysis of bi-quasiprimitive highy-arc-transitive digraphs.

Jung Won Cho *(University of St Andrews)*

Tuesday 1 July, 11:36–11:45 • Room 122

Short Communications IV

Howson property for monogenic inverse semigroups

An algebra is said to have the Howson property if the intersection of any two finitely generated subalgebras is again finitely generated. In this talk, we will look at the Howson property for monogenic inverse semigroups regarded as ordinary semigroups. We will see that a monogenic inverse semigroup has the Howson property if and only if it is not the monogenic free inverse semigroup. This is joint work with Craig Miller and Nik Ruškuc.

Fernanda Cipriano *(Universidade Nova de Lisboa)*

Tuesday 1 July, 14:48–15:12 • Room 106

Thematic Session: Spatio-temporal and extreme statistical analysis

Invariant measures for a class of stochastic third grade fluid equations in 2D and 3D bounded domains

TBA

Carlos A. Coelho *(NOVA University of Lisbon)*

Thursday 3 July, 11:00–11:22 • Room 106

Thematic Session: Advances in Inference and Modeling: formal and computational aspects

A likelihood Ratio Test for High-dimensional Sphericity based on a Dual Approach

What may clearly be taken as a likelihood ratio test for the hypothesis of sphericity and the hypothesis of multiple sphericity, where we test simultaneously the equality of several covariance matrices and their sphericity is obtained using a dual approach, where the roles of variables and observations appear switched. The exact distribution of the test statistic is obtained and sharp near-exact distributions are also developed, with no need for any assumptions on either the sample size (n) or the number of variables (p), other than that n<p. A simulation study shows the perfect adequacy of the test, with a full Type I error control, very good power and its suitability to handle different underlying distributions, even skewed and heavy tailed ones.

Isabel Colaço *(Instituto Politécnico de Beja, Portugal)*

Thursday 3 July, 14:20–14:40 • Room 106

Thematic Session: Commutative Monoids

Minimal free resolution of Generalized Repunit Algebras

Let k be an arbitrary field and let $b > 1, n > 1$ and a be three positive integers. In this talk we explicitly describe a minimal $S-$graded free resolution of the semigroup algebra $k[S]$ when S is a generalized repunit numerical semigroup, that is, when S is the submonoid of $\mathbb{N}$ generated by $\{a_1, a_2, \ldots, a_n\}$ where $a_1 = \sum_{j=0}^{n-1} b^j$ and $a_i - a_{i-1} = a\, b^{i-2}$, $i = 2, \ldots, n$, with $gcd(a, a_1) = 1$.

Marston Conder *(University of Auckland, New Zealand)*

Thursday 3 July, 15:30–16:00 • Room 103

Thematic Session: Groups 3

Some unexpected theoretical consequences of computations involving symmetry

In this talk I will give some instances of computations involving actions of groups (on graphs and maps with a high degree of symmetry) that led to unexpected theoretical discoveries. These include discoveries about the genus spectra of particular classes of regular maps on surfaces, and a very recent one about the kinds of automorphism groups they have, and related earlier discoveries about symmetric graphs that led to new presentations for special linear groups over the integers, as well as a closed-form definition for the binary reflected Gray codes. Such examples highlight the way in which computational experiments can have surprising theoretical outcomes.

José Carlos Costa *(CMAT, University of Minho)*

Wednesday 2 July, 11:54–12:03 • Room 110

Short Communications VII

The ω-word problem over the pseudovariety of aperiodic block groups

An ω-term is a formal expression obtained from the letters of an alphabet using the operations of multiplication and ω-power. The ω-word problem for a pseudovariety $\mathbf{V}$ of finite semigroups consists in deciding whether two ω-terms have the same interpretation over every semigroup of $\mathbf{V}$.

The ω-word problem has been solved for several aperiodic pseudovarieties. The case of the pseudovariety $\mathbf{J}$ of all $\mathcal{J}$-trivial semigroups, solved by J. Almeida [1], constitutes a classical example. Another notable example is that of the pseudovariety $\mathbf{A}$ of all aperiodic semigroups, solved by J. McCammond [3] by transforming each ω-term into a certain normal form and showing that different normal forms have different interpretations in some finite aperiodic semigroup. The decidability of the word problem for ω-terms was also obtained for the pseudovariety $\mathbf{A} \cap \mathbf{ECom}$, of aperiodic semigroups whose idempotents commute, by the speaker in collaboration with M. Branco [2]. The characterization of the ω-terms over $\mathbf{A} \cap \mathbf{ECom}$ is given by certain reduced automata associated with the terms.

Recall that a block group is a semigroup whose elements have at most one inverse. A block group can also be defined as a semigroup in which each $\mathcal{R}$-class and each $\mathcal{L}$-class have at most one idempotent. This talk deals with the ω-word problem over the pseudovariety $\mathbf{A} \cap \mathbf{BG}$, of all aperiodic block groups. This problem is reduced to considering only ω-terms of ranks 1 and 2. For rank 1, the solution is the same as $\mathbf{A}$. For rank 2 the solution over $\mathbf{A} \cap \mathbf{BG}$ combines the solutions over $\mathbf{A}$, $\mathbf{J}$ and $\mathbf{A} \cap \mathbf{ECom}$.

This is a joint work with Conceição Nogueira and M. Lurdes Teixeira.

References

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[2] *M. J. Branco and J. C. Costa,* On ω-Identities over Finite Aperiodic Semigroups with Commuting Idempotents, *Springer Proceedings in Mathematics and Statistics, 2021, vol. 345, pp. 169–178.*

[3] *J. McCammond,* Normal forms for free aperiodic semigroups, *Int. J. Algebra Comput. **11** (2001), 581–625.*

Marco André da Silva Costa *(University of Aveiro)*

Thursday 3 July, 12:06–12:28 • Room 106

Thematic Session: Advances in Inference and Modeling: formal and computational aspects

Improving Parameter Estimation in State-Space Models via Double-Iterated GMM

This communication presents a new bias-corrected estimation method for state-space models: the double-iterated Generalized Method of Moments (GMM2i). Unlike traditional estimators such as maximum likelihood (ML), which rely on strong distributional assumptions and may perform poorly in small samples or under model misspecification, GMM2i uses moment conditions and Kalman filter predictors to iteratively reduce bias. Its performance is assessed through simulations, in comparison with ML and a hybrid maximum likelihood method (h-ML). Results indicate that h-ML reduces bias in autoregressive parameter estimates, while GMM2i outperforms ML in small-sample, high-variance scenarios. A real-data application supports these findings, with h-ML achieving the lowest standardized mean squared error (MSSE), and all methods providing similar confidence intervals, confirming their robustness.

Rémi Delaby *(Université Libre de Bruxelles)*

Wednesday 2 July, 12:12–12:21 • Room 106

Short Communications VI

Geometries with trialities arising from linear spaces

A triality is a sort of super-symmetry that exchanges the types of the elements of an incidence geometry in cycles of length three. Although geometries with trialities exhibit fascinating behaviors, their construction is challenging, making them rare in the literature. To understand trialities more deeply, it is crucial to have a wide variety of examples at hand. In this article, we introduce a general method for constructing various rank-three incidence systems with trialities. Specifically, for any rank two incidence system Γ*, we define its triangle complex* $\Delta(\Gamma)$*, a rank three incidence system whose elements consist of three copies of the flags (pairs of incident elements) of* Γ*. This triangle complex always admits a triality that cyclically permutes the three copies. We then explore in detail the properties of the triangle complex when* Γ *is a linear space, including flag-transitivity, the existence of dualities, and connectivity properties. As a consequence of our work, this construction yields the first infinite family of thick, flag-transitive and residually connected geometries with trialities but no dualities.*

Persi Diaconis *(Stanford University)*

Wednesday 2 July, 16:30–17:15 • Auditorium

Plenary Session VIII

Combinatorics and the Sylow theorems

There are simple, interesting problems that remain open about the Sylow-p subgroups of the symmetric group(!). One is to enumerate the number and sizes of the Sylow-p double cosets. A second is to understand the way double cosets multiply and combine (Hecke Algebra). In joint work with Eugenio Giannelli, Bob Guralnick, Stacey Law, Gabriel Navarro, Benjamin Sambale and Hunter Spink, we offer a few answers and a few open problems. I'll try to explain all this in an elementary way.

João Dias *(Universidade de Évora)*

Tuesday 1 July, 11:27–11:36 • Room 103

Short Communications I

A Survey of Meadows in Algebra

The rational numbers have been used to measure quantities since ancient times; however, their implementation in computer languages raises a significant problem: zero has no inverse. To address this issue, J.

Bergstra and J. Tucker introduced an algebraic structure called a meadow, which allows for the inversion of zero.

In this talk, I will introduce meadows and their various classes, demonstrating that they are unions of rings and serve as generalizations of unital commutative rings. We will explore how concepts from ring theory, such as Artinian rings and decomposition theorems, can be adapted to this new context. Finally, I will present a generalization to non-comutative meadows

This work is joint with B. Dinis and P. Marques.

Mikhailo Dokuchaev *(Universidade de São Paulo)*

Monday 30 June, 15:00–15:30 • Room 106

Thematic Session: Inverse semigroups, restriction semigroups and related algebras

(Co)homology of skew product algebras by inverse monoid actions with application to Steinberg algebras

Given a unital action of an inverse monoid S on an algebra A and a bimodule M over the skew product algebra $A *_\theta S$, we construct a (co)homology Grothendieck spectral sequence which converges to the Hochschild (co)homology of $A *_\theta S$ with values in M. The spectral sequence involves the (co)homology of S and the Hochschild (co)homology of A, when applied to unital Steinberg algebras over a field and also in the case of an E-unital S, whose action θ on A is compatible. Moreover, in the case of a Steinberg algebra, the homology spectral sequence collapses on p-axis, resulting in an isomorphism of homology groups.

This is a joint work with Mykola Khrypchenko and Juan Jacobo Simón.

Igor Dolinka *(University of Novi Sad)*

Tuesday 1 July, 15:30–16:00 • Room 110

Thematic Session: Geometric and combinatorial (inverse) semigroup theory 2

Some new results on right units of special inverse monoids

I will present the recent results – in collaboration with Robert D. Gray (University of East Anglia) – aimed at the study and possible characterisation of (right cancellative, finitely generated) monoids arising as the monoids of right invertible elements of finitely presented special inverse monoids. In particular, we compare the class $\mathcal{RU}$ of such monoids with: the class $\mathcal{P}$ of prefix monoids of finitely presented groups, the class $\mathcal{RC}_1$ of finitely generated submonoids of finitely RC-presented monoids, and $\mathcal{RC}_2$, the class of recursively RC-presented monoids. Our conclusions follow from several general results on finite generation and presentability of maximal subgroups of special inverse monoids, stemming from some arguments with a definite geometric flavour.

James East *(Western Sydney University)*

Thursday 3 July, 15:30–16:00 • Room 110

Thematic Session: Geometric and combinatorial (inverse) semigroup theory 3

Transformation representations of diagram monoids

Cayley's Theorem states that any finite monoid can be faithfully represented as a semigroup of transformations (self-maps) of a finite set. The minimum size of such a set is the (minimum transformation) degree *of the monoid.*

We obtain formulae for the degrees of the most well-studied families of finite diagram monoids, including the partition, Brauer, Temperley–Lieb and Motzkin monoids. For example, the partition monoid $\mathcal{P}_n$ has degree $1 + \frac{B(n+2)-B(n+1)+B(n)}{2}$ for $n \geq 2$, where these are Bell numbers. The proofs involve constructing explicit faithful representations of the minimum degree, many of which can be realised as (partial) actions on projections.

This is joint work with Reinis Cirpons and James Mitchell, both at Univ St Andrews.

Ruy Exel *(Universidade Federal de Santa Catarina, Florianópolis)*

Monday 30 June, 14:00–14:30 • Room 106

Thematic Session: Inverse semigroups, restriction semigroups and related algebras

Twisted Steinberg algebras, regular inclusions and induction

Given a field K and an ample (not necessarily Hausdorff) groupoid G, we define the concept of a line bundle over G inspired by the well known concept from the theory of C-algebras. If E is such a line bundle, we construct the associated twisted Steinberg algebra in terms of sections of E, which turns out to extend the original construction introduced independently by Steinberg in 2010, and by Clark, Farthing,* *Sims and Tomforde in a 2014 paper (originally announced in 2011). We also generalize (strictly, in the non-Hausdorff case) the 2023 construction of (cocycle) twisted Steinberg algebras of Armstrong, Clark, Courtney, Lin, Mccormick and Ramagge. We then extend Steinberg's theory of induction of modules, not only to the twisted case, but to the much more general case of regular inclusions of algebras. Our main result shows that, under appropriate conditions, every irreducible module is induced by an irreducible module over a certain abstractly defined isotropy algebra. This is joint work with Misha Dokuchaev and Hector Pinedo, based on a recent paper dedicated to the memory of Fernando Abadie.*

Maria Elisa Fernandes *(Universidade de Aveiro)*

Wednesday 2 July, 11:00–11:45 • Auditorium

Plenary Session VI

Independent sets and geometries for symmetric and alternating groups

An independent set *in a group G is a subset of elements such that no element lies in the subgroup generated by the others. The problem of determining the maximal size $\mu(G)$ of such a set gained relevance following results by Diaconis and Saloff-Coste giving the bound $|G|^{O(\mu(G))}n^2\log(n)$ for the time it takes for a random walk on the group G to approach the uniform distribution. When G is the symmetric group* $\mathrm{Sym}(n)$*, Whiston proved that the maximal size of an independent generating set is $n-1$. Cameron and Cara later classified all such maximal independent sets and demonstrated that they are* strongly independent*, meaning they satisfy the* intersection property (IP)*: $\langle \rho_i : i \in J\rangle \cap \langle \rho_i : i \in K\rangle = \langle \rho_i : i \in J \cap K\rangle$, for any subsets J, K of the index set.*

This property plays a central role in Tits's theory of coset geometries. In particular, abstract regular polytopes can be constructed from strongly independent sets of involutions. Moreover, these sets can be ordered such that non-consecutive generators commute — a property known as the string property (SP).

A group generated by involutions is called a C-group*, a* sggi*, or a* string C-group *if it satisfies the intersection property (IP), the string property (SP), or both, respectively. Coset geometries arising from C-groups exhibit many structural similarities with abstract regular polytopes and are known as* regular hypertopes*. The classification of Cameron and Cara of maximal independent sets for* $\mathrm{Sym}(n)$ *includes the classification of regular hypertopes of maximal rank. Only one set of generators in this classification is a string C-group, namely $[(1\,2),(2\,3),\dots,(n{-}1\,n)]$, which is the automorphism group of the regular simplex.*

For the alternating group $\mathrm{Alt}(n)$*, it is known that the maximal rank of a string C-group (equivalently, the rank of an abstract regular polytope with automorphism group* $\mathrm{Alt}(n)$*) is $\lfloor (n-1)/2 \rfloor$ when $n \geq 12$.*

More recently, we have shown that the maximal size of an independent sggi in $\mathrm{Alt}(n)$ *is $\lfloor \frac{3(n-1)}{5} \rfloor$ for $n \geq 9$, and showed that this bound is tight when $n \equiv 0, 1, 4 \pmod 5$.*

This talk will present these results and explore several related resolved and open problems. The work discussed here was carried out in collaboration with Jessica Anzanello, Peter Brooksbank, Peter Cameron, Dimitri Leemans, Mark Mixer, and Pablo Spiga.

Ana Ferreira *(Instituto Superior Técnico da Universidade de Lisboa)*

Tuesday 1 July, 14:24–14:48 • Room 106

Thematic Session: Spatio-temporal and extreme statistical analysis

Non-stationary extremes: a spatio-temporal scedasis approach

Recently tail expansions for the empirical distribution and quantile functions have been obtained, under usual maximum domain of attraction conditions and non-stationarity conditions [1]. The later relate to the existence of scedasis in the marginal distributions and a tail distributions equivalence property, a way to extend "independent and identically distributed" assumptions. The results provide basic tools for extending and developing novel estimators along with asymptotic properties. We illustrate the results with some theoretical examples and an application.

[1] Einmahl J.H.J., Ferreira A., de Haan L., Neves C. and Zhou C. (2022). Spatial dependence and space-time trend in extreme events. Annals of Statistics, 50, 30-52. https://doi.org/10.1214/21-AOS2067

Ana Cristina Moreira Freitas *(Universidade do Porto)*

Tuesday 1 July, 14:00–14:24 • Room 106

Thematic Session: Spatio-temporal and extreme statistical analysis

Extremal index, rare events point processes, clustering and periodicit

We consider stationary stochastic processes arising from dynamical systems by evaluating a given observable along the orbits of the system. We focus on the occurrence of extremal observations corresponding *to exceedances of high thresholds, which is related to the entrance in certain neighbourhoods of the set of points where the observable is maximised. We study extreme value laws and rare events point processes both in the absence and presence of clustering of exceedances.*

Jorge Milhazes Freitas *(Universidade do Porto)*

Tuesday 1 July, 15:12–15:36 • Room 106

Thematic Session: Spatio-temporal and extreme statistical analysis

Spatio-temporal analysis of multivariate extremes for dynamical systems

We establish a theory for multivariate extreme value analysis of dynamical systems. Namely, we provide conditions adapted to the dynamical setting which enable the study of dependence between extreme values of the components of R^d-valued observables evaluated along the orbits of the systems. We study this cross-sectional dependence, which results from the combination of a spatial and a temporal dependence structures. We give several illustrative applications, where concrete systems and dependence sources are introduced and analysed.

Matthias Fresacher *(Western Sydney University)*

Tuesday 1 July, 11:18–11:27 • Room 122

Short Communications IV

Categorical representation of DRC-semigroups

DRC-semigroups model associative systems with domain and range operations, and contain many important classes, such as inverse, restriction, Ehresmann, regular $*$-, and $*$-regular semigroups. In this joint work with James East, Azeef Muhammed and Tim Stokes, we show that the category of DRC-semigroups is isomorphic to a category of certain biordered categories whose object sets are projection algebras in the sense of Jones. This extends the recent groupoid approach to regular $*$-semigroups of East and Muhammed. We also establish the existence of free DRC-semigroups by constructing a left adjoint to the forgetful functor into the category of projection algebras.

M. Ángeles Moreno Frías *(Universidad de Cádiz)*

Thursday 3 July, 14:00–14:20 • Room 106

Thematic Session: Commutative Monoids

Elasticity of a numerical semigroup and packed semigroups

Let S be a numerical semigroup and $\mathrm{msg}(S) = \{n_1, \cdots, n_e\}$ *its minimal system of generators. Then* $\mathrm{m}(S) = \min(\mathrm{msg}(S))$, $\mathrm{m}(S) = \max(\mathrm{msg}(S))$, *and* $\mathrm{e}(S)$ *the cardinality of* $(\mathrm{msg}(S))$, *are called the multiplicity, comultiplicity and embedding dimension of S, respectively.*

If $s \in S$ denote by $\mathsf{L}(s) = \{\lambda_1 + \cdots + \lambda_e \mid (\lambda_1, \cdots, \lambda_e) \in \mathbb{N}^e$ and $\lambda_1 n_1 + \cdots + \lambda_e n_e = s\}$. Define the elasticity of s as $\mathscr{S}(s) = \frac{\max(\mathsf{L}(s))}{\min(\mathsf{L}(s))}$. The elasticity of a numerical semigroup S, is defined as $\mathscr{S}(S) = \max\{\mathscr{S}(s) \mid s \in S\}$. In [2] we can see that the computation of the elasticity of a numerical semigroup is easy, because given a numerical semigroup S, in Example 3.1.6 in [2] it is shown that $\mathscr{S}(S) = \frac{\mathrm{m}(S)}{\mathrm{m}(S)}$.

In this talk, we study the following three sets:

- $\mathscr{L}(\mathrm{m}(S) = m, \mathrm{m}(S) = M) = \{S \mid S$ *is a numerical semigroup,* $\mathrm{m}(S) = m$ *and* $\mathrm{m}(S) = M\}$. *In particular, we present an algorithm based in [3] to compute all its elements.*

- $\mathscr{L}(\mathrm{m}(S) = m, \mathscr{S}(S) \leq q) = \{S \mid S$ *is a numerical semigroup,* $\mathrm{m}(S) = m$ *and* $\mathscr{S}(S) \leq q\}$.

  Following the notation introduced in [1], a packed numerical semigroup is a numerical semigroup S such that $\mathrm{m}(S) \leq 2\,\mathrm{m}(S) - 1$. We denote by $\mathscr{P}(\mathrm{m}(S) = m, \mathscr{S}(S) \leq q) = \{S \in \mathscr{L}(\mathrm{m}(S) = m, \mathscr{S}(S) \leq q) \mid S$ is a packed numerical semigroup$\}$. Over the set $\mathscr{L}(\mathrm{m}(S) = m, \mathscr{S}(S) \leq q)$, we define an equivalence binary relation $\mathscr{R}$ and we will see that

  $$\frac{\mathscr{L}(\mathrm{m}(S) = m, \mathscr{S}(S) \leq q)}{\mathscr{R}} = \{[S] \mid S \in \mathscr{P}(\mathrm{m}(S) = m, \mathscr{S}(S) \leq q)\}.$$

  Therefore, to compute all the elements of $\mathscr{L}(mul{=}m, elas \leq q)$, it is enough:

  (1) Compute $\mathscr{P}(mul{=}m, elas \leq q)$.

  (2) For every $\Delta \in \mathscr{P}(mul{=}m, elas \leq q)\}$, compute $[\Delta]$.

  We present some algorithmic procedures which allows to compute (1) and (2).

- $\mathscr{L}(\mathrm{e}(S)=3, \mathscr{S}(S))=q)=\{S \mid S$ *is a numerical semigroup,* $\mathrm{e}(S)=3$ *and* $\mathscr{S}(S)=q\}$.
  We will see that if $q=\frac{b}{a}$ *with* $\{a,b\} \subseteq \mathbb{N}$ *and* $\gcd\{a,b\}=1$, *then the set*

  $$\{\{\mathscr{L}(\mathrm{e}(S)=3, \mathrm{m}(S)=ka, \mathrm{m}(S)=kb) \mid k \in \mathbb{N}\backslash\{0\}\}$$

  is a partition of $\mathscr{L}(\mathrm{e}(S)=3, \mathscr{S}(S)=q)$. *This fact allows us to describe some algorithmic procedures to compute* $\mathscr{L}(\mathrm{e}(S)=3, \mathscr{S}(S)=q)$.

[1] García-García, J.I.; Marín-Aragón, D.; Moreno-Frías, M.A. ; Rosales J.C. and Vigneron-Tenorio A., Semigroups with fixed multiplicity and embedding dimension *Ars Math. Contemp. 17 (2019), 397–417.* https://doi.org/10.26493/1855-3974.1937.5ea

[2] Geroldinger, A.; Halter-Koch F., Non-Unique Factorizations Algebraic, Combinatorial and Analytic Theory, *Pure and Applied Mathematics 278 Chapman Hall/CRC, 2006.*

[3] Branco, M.B.; Ojeda I. and Rosales J.C., The set of numerical semigroups of a given multiplicity and Frobenius number, *Port. Math. 78 (2001), 147–167.* https://doi.org/10.4171/pm/2064

Ajda Lemut Furlani *(University of of Ljubljana)*

Thursday 3 July, 15:00–15:30 • Room 110

Thematic Session: Geometric and combinatorial (inverse) semigroup theory 3

The solution of the word problem in the free F-birestriction monoid in enriched signature

Birestriction monoids in which every σ-class has a maximum element are called F-birestriction monoids. They are non-regular analogues of F-inverse monoids and form a variety of algebras in the extended signature $(\cdot,^*,^+,m,1)$, where m is the unary operation that maps each element to the maximum element of its σ-class. The talk will present the solution of the word problem for the free X-generated F-birestriction monoid $\mathsf{FFBR}(X)$ and its strong and perfect analogues. We find a decomposition of $\mathsf{FFBR}(X)$ as a partial action product of the idempotent semilattice of its universal inverse monoid by the free monoid X^* which reduces the word problem in $\mathsf{FFBR}(X)$ to the word problem in its universal inverse monoid. We solve the latter problem by applying Stephen's procedure and showing that Schützenberger graphs of elements of this inverse monoid are finite and effectively constructible. Similar methods apply to solving the word problem in the strong and perfect analogues of $\mathsf{FFBR}(X)$. This is joint work with Ganna Kudryavtseva.

Tom Goertzen *(University of Sydney)*

Thursday 3 July, 11:00–11:30 • Room 122

Thematic Session: Automated Reasoning and the Future of Mathematical Practice

Extracting Proofs from Magma into Lean

Lean is a powerful language for computer-verified proofs. However, entering every detail by hand can be tedious, especially for large examples. In this talk, I will present a framework for extracting data and examples from MAGMA into Lean. The guiding example, for this talk, will be the Mathieu group M11. I will also touch on current challenges and possible future directions. This talk is based on joint work with Ashvni Narayanan.

Jesus Baena Gomez *(Universidad de Sevilla. Dpto. Geometria y Topologia)*

Tuesday 1 July, 11:18–11:27 • Room 103

Short Communications I

Finite dimensional Tortkara algebras and combinatorial structures

This paper explores the connection between combinatorial structures—here referred to as configurations—and Tortkara algebras, identifying which configurations correspond to these algebras. For each configuration, the associated Tortkara algebra is analyzed with respect to solvability and nilpotency. Additionally, the isomorphism classes of algebras arising from each configuration are examined, providing a new approach to their classification. To complement the theoretical results, two algorithmic tools are introduced: one to verify whether a given algebra is Tortkara, and another to construct and visualize the digraph associated with a Tortkara algebra.

Victoria Gould *(University of York)*

Thursday 3 July, 09:00–09:45 • Auditorium

Plenary Session IX

Diameter of pseudo-finite semigroups

A semigroup S is said to be right pseudo-finite *if the universal right congruence on S can be generated by a finite set $U \subseteq S \times S$, and there is a bound on the length of derivations for an arbitrary pair $(s,t) \in S \times S$ as a consequence of those in U. The* right diameter *of such a semigroup is then the smallest bound taken over all finite generating sets. There is a dual notion of being* left pseudo-finite *and of* left diameter*. The properties of being right, or left, pseudo-finite are finitary conditions, in that any finite S is both right and left pseudo-finite with right and left diameter 0 (if S is trivial) or 1 (take $U = S \times S$). On the other hand, some well-known uncountable semigroups also have right and left diameter 1.*

This talk will give an introduction to the notion of pseudo-finiteness and diameter, explaining how they arise arise from a number of diverse sources. We then focus on the right and left diameter of some natural semigroups of mappings of sets, and of order-preserving mappings of chains. In the latter case, the right diameter is determined by the structure of the chain. So far, for all 'natural' right or left pseudo-finite semigroups, the corresponding diameter has been found to be at most 4.

The work presented comes from many sources: the most recent is joint work with James East, Craig Miller, Tom Quinn-Gregson and Nik Ruškuc.

Ambroise Grau *(Universidade Nova de Lisboa)*

Tuesday 1 July, 11:09–11:18 • Room 110

Short Communications III

Extended Green's relations of the stylic monoid

Extended Green's relations, which are akin to cancellativity properties, are equivalence relations used to better understand the structure of semigroups which are not regular. In this talk, we will describe this relations in the stylic monoid, a finite plactic-like monoid introduced by Abram and Reutenauer which can be studied both in an algebraic and in a combinatoric fashion.

Indeed, given an ordered alphabet A of size n, the stylic monoid of rank n is the quotient of the free monoid A^* by the Knuth relations (used to define the plactic monoid), together with the relations $a^2 = a$ for each letter a of A. This monoid also corresponds to the monoid of all N-tableaux on A (a special type of semistandard Young tableaux in which each row is strictly increasing and contained in the previous one) where the operation on elements is done using an adapted version of Schensted algorithm for left and right insertion. Because of the finitary aspect of this monoid, its behaviour is very different from that of the plactic monoid, and describing the extended Green's relations requires a deep understanding of the combinatoric structure of this monoid. As an example, an element u admits a left identity e if and only if all the letters present in e lie in the first column of u when these elements are viewed as N-tableaux. We will thus present some results and try to explain some of the strange behaviour that can be seen in this monoid.

Luís M. Grilo *(University of Évora)*

Thursday 3 July, 11:22–11:44 • Room 106

Thematic Session: Advances in Inference and Modeling: formal and computational aspects

Estimator-Related Matrix Issues in Structural Equation Modeling with Ordinal Data

Survey questionnaires often include items measured on ordinal scales, such as Likert-type questions, which produce data that do not follow a multivariate normal distribution. Additionally, these surveys are frequently based on small sample sizes, presenting challenges for the estimation of structural equation models (SEM) using the Maximum Likelihood (ML) method, which relies on the Pearson correlation matrix and assumes normality and continuous variables. To address these limitations, the Diagonally Weighted Least Squares (DWLS) estimator is often employed in SEM involving ordinal or nonnormally distributed data. DWLS utilizes polychoric (or polyserial) correlations and simplifies computation by using only the diagonal elements of the weight matrix, thereby improving computational efficiency and numerical stability, especially with small to moderate samples. However, DWLS still has vulnerabilities: it can be sensitive to small samples, model misspecification, and in some implementations, requires large samples for accurate estimation of polychoric correlations. In certain situations, issues such as non-invertibility of the information matrix or a non-positive definite variance-covariance matrix (negative eigenvalues) may arise, potentially indicating problems like model non-identification. An alternative estimator, consistent Partial Least Squares (PLSc), has gained attention for both exploratory and confirmatory research. Although originally designed for continuous data, PLSc has demonstrated strong performance with ordinal data, especially under conditions of small sample sizes and nonnormal distributions. A comparative statistical analysis was conducted using case studies to evaluate the performance of DWLS and PLSc. The findings suggest that PLSc is a viable and sometimes preferable alternative when DWLS proves unsuitable.

Sergey Gusev *(Ural Federal University, Russia)*

Tuesday 1 July, 11:00–11:09 • Room 122

Short Communications IV

Finiteness conditions for lattices of monoid varieties

We classify all varieties of aperiodic monoids with central idempotents whose subvariety lattice is finite or satisfies the descending chain condition or satisfies the ascending chain condition. It turns out that for varieties in this class, the properties of having a finite subvariety lattice and a subvariety lattice satisfying the ascending chain condition are equivalent, and thus the property of having a subvariety lattice satisfying the ascending chain condition implies the one of having a subvariety lattice satisfying the descending chain condition.

Stefan Gyurki *(Slovak University of Technology, Bratislava)*

Monday 30 June, 11:22–11:44 • Room 103

Thematic Session: Groups and Graphs

Small vertex transitive directed strongly regular graphs

In the talk we report about a systematic computer assisted search for small vertex transitive directed strongly regular graphs. The enumeration of such graphs was previously known up to order 20, here we extend the catalogue of such digraphs up to order 31. Our enumeration has been done using computer system GAP and we were essentially relying on the existing catalogue of small association schemes by Hanaki and Miyamoto.

This research was supported from the APVV Research grants 22-0005, 23-0076 and VEGA Research grants 1/0069/23 and 1/0011/25.

Nohra Hage *(Université Catholique de Lille)*

Tuesday 1 July, 11:54–12:03 • Room 110

Short Communications III

Shifted Yamanouchi domino tableaux and Q-Schur Products

Schur functions are traditionally defined via semistandard Young tableaux and have deep connections to representation theory and Schubert calculus. The product of two Schur functions can be expressed combinatorially using domino tableaux, as shown by Stanton and White and later refined by Carré and Leclerc. Analogously, Q-Schur functions, introduced for shifted partitions, can be decomposed using shifted domino tableaux, as demonstrated by Chemli. In this talk, we propose a new combinatorial model for the product of Q-Schur functions by introducing Yamanouchi shifted domino tableaux.

Haleh Hamdi *(CEMAT, Faculty of Science, University of Lisbon)*

Wednesday 2 July, 11:54–12:03 • Room 103

Short Communications V

Clifford regularity in the context of graded integral domains

A commutative semigroup S is called Clifford if every element $s \in S$ is regular in the sense of Von Neumann, meaning that there exists an element $a \in S$ such that $s^2a = s$. Assume that D is an integral domain. The factor semigroup $\mathcal{I}(D) := F(D)/P(D)$ is referred to as the class semigroup of D, where $F(D)$ and $P(D)$ denote the sets of nonzero fractional ideals and principal fractional ideals of D, respectively. An integral domain D is called a Clifford regular domain if $\mathcal{I}(D)$ is a Clifford semigroup. The purpose of this talk is to explore Clifford regularity within the context of integral domains graded by a torsionless commutative cancellative monoid. We will examine the conditions under which the semigroup ring $D[\Gamma]$, where Γ is a nonzero torsionless commutative cancellative monoid, is a Clifford regular domain.

Scott Harper *(University of Birmingham)*

Tuesday 1 July, 15:30–16:00 • Room 103

Thematic Session: Groups 2

Generating infinite simple groups

I will discuss recent work on generating infinite simple groups.

Daniel Heath *(University of Manchester)*

Thursday 3 July, 14:30–15:00 • Room 110

Thematic Session: Geometric and combinatorial (inverse) semigroup theory 3

Growth of monogenic free adequate monoids

The class of (left) adequate semigroups forms a quasivariety sitting above inverse semigroups, and as such free objects exist for any rank. Akin to Munn's folded tree descriptions for the free inverse semigroup, the free (left) adequate semigroup has a tree-like model due to Kambites, with retractions forming the transition from Stallings' foldings. This description is somewhat technical, but we use this description in considering the growth of FLAd(X) in terms of edges of trees. Whilst this appears difficult in general, we present results in the monogenic case and show that $FLAd_1$ *grows intermediately in terms of partitions of naturals, whilst* FAd_1 *grows exponentially. This is joint work with T. Aird (University of Manchester).*

Lígia Henriques-Rodrigues *(University of Évora)*

Tuesday 1 July, 15:36–16:00 • Room 106

Thematic Session: Spatio-temporal and extreme statistical analysis

Improved Estimation of the Extreme Value Index for Risk Assessment: Bias-Reduced Methods and Applications

Estimating the extreme value index (EVI) plays a central role in extreme value theory, as it governs the tail heaviness of probability distributions and directly informs the quantification of risks associated with rare and extreme events. In heavy-tailed settings—where the EVI is positive—the Hill estimator is a standard tool, though it is often affected by bias, which can distort risk estimates and undermine inference. This work introduces new families of bias-reduced estimators for the EVI, aiming to enhance estimation accuracy, particularly in finite samples. A comparative analysis is carried out, focusing on generalized Hill-type estimators available in the literature. Through Monte Carlo simulations, the performance of these new estimators is evaluated, with particular attention to their implications for risk estimation. The practical value of the proposed methods is further illustrated with an application to an environmental dataset, demonstrating how improved EVI estimation can lead to more reliable assessments of extreme event risk. Joint work with Frederico Caeiro and M. Ivette Gomes

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Susan Holmes *(Stanford University)*

Monday 30 June, 11:30–12:00 • Auditorium

Thematic Session: Design of Experiments: Mathematical, Computational and Statistical Aspects

Computational Design of Experiments using Generative Models

TBA

Marcel Jackson *(La Trobe University)*

Monday 30 June, 12:06–12:28 • Room 103

Thematic Session: Groups and Graphs

Chromatic Algebras

Non-associative Relation Algebras (nRA) form the basic framework for the algebraic foundations of qualitative reasoning models. From a purely combinatorial perspective, the "chromatic algebras" are perhaps the simplest class to motivate, as qualitative representations correspond to a kind of Ramsey-theoretic condition on edge colourings of complete graphs: each 3-clique must avoid some forbidden combination of colours, but also, each non-forbidden 3-clique colouring must appear somewhere. In this talk we give an overview of some of the interesting problems in this area, and of the complete classification of which combinations of forbidden colour combinations allow for both constraints to be satisfied. As well as touching on classical Ramsey theory, the talk will also touch on quasigroups, and finite linear spaces (in the sense of incidence geometries). This work is joint with Badriah al Juaid (La Trobe University and Taif University), Tomasz Kowalski (Jagiellonian University) and James Koussas (La Trobe University).

Marianne Johnson *(University of Manchester)*

Thursday 3 July, 09:45–10:30 • Auditorium

Plenary Session IX

Forbidden configurations for coherency

Coherency is one of a suite of natural finitary conditions for monoids: a monoid S is said to be right (dually, left) coherent if every finitely generated subact of every finitely presented right (dually, left) S-act is finitely presented, and S is said to be coherent if it is both right and left coherent. The problem of determining whether a given monoid (or is not) coherent can be technically challenging, and disparate techniques have been developed to tackle this question for several interesting monoids, including the monoids arising as the free objects in each of the following varieties: monoids, groups, inverse monoids, ample monoids, and left ample monoids. We exhibit a particular configuration of elements that prohibits left (respectively, right) coherence in certain monoid subsemigroups S of a right (respectively, left) E-Ehresmann monoid F, and apply this technique to show that the free left Ehresmann monoid of rank at least 2 is not left coherent and the free Ehresmann monoid of rank at least 2 is neither left nor right coherent. Our technique simplifies significantly in the case where the overmonoid F is an E-unitary inverse monoid, and we apply this to recover the (negative) results of Gould and Hartmann, namely: the free inverse monoids and free ample monoids of rank at least 2 are neither left nor right coherent, and the free left ample monoid of rank at least 2 is not left coherent. In a positive direction, we show that the free left Ehresmann monoid is weakly coherent.

This is joint work with Victoria Gould.

Claudia Justus *(Stellenbosch University)*

Tuesday 1 July, 11:00–11:09 • Room 103

Short Communications I

Constructing Q-ideals for Boolean semiring partitioning using seeds

A semiring is a generalization of a ring, where it is not required for each element to have an additive inverse. Partitioning elements of semirings into subsets according to their properties is central to mathematics and applications thereof. By grouping similar elements together, we identify relationships within and across these subsets that may not have been immediately clear in the unpartitioned structure. It is well-known that the quotient of a ring with respect to an ideal, partitions the ring. This, however, need not be true for semirings, making partitioning a semiring a non-trivial matter. The purpose of this talk is to add to the theory of semirings by proposing a novel method for constructing Q-ideals to partition a subclass of Boolean semirings. Utilizing this new method, we develop a nested hierarchical partitioning algorithm based on the number of non-zero entries of a selected Boolean vector. Using the Jaccard index, we measure the 'goodness' of a Q-ideal partition, a ratio between its average within- and between-similarity, and show that our proposed method consistently yields good partitions.

Mark Kambites *(University of Manchester)*

Tuesday 1 July, 14:00–14:30 • Room 110

Thematic Session: Geometric and combinatorial (inverse) semigroup theory 2

Maximal subgroups of special inverse monoids 1

I will discuss what is known, and what remains unknown, about the group of units and other subgroups of inverse monoids defined by presentations where all the relations take the form $w = 1$. The original results mentioned are joint work with Robert D. Gray (University of East Anglia).

Michael Kinyon *(University of Denver)*

Thursday 3 July, 11:00–11:22 • Room 110

Thematic Session: Conjugacy and Induced actions in groups, semigroups, and automata

The inverse monoid of partial inner automorphisms of a semigroup

A partial automorphism of an algebra is an isomorphism between subalgebras. Under composition of partial maps, the set of all partial automorphisms of an algebra generates an inverse monoid.

In groups, there is an intrinsic notion of automorphism induced by conjugacy, namely inner automorphisms. The group conjugacy relation has several different generalizations to semigroups. One of these, natural conjugacy introduced by Konieczny, turns out to induce an intrinsic notion of partial automorphism on any semigroup. We call these inner partial automorphisms.

In this talk, after a quick review of natural conjugacy, I will introduce partial inner automorphisms, show that they have particularly good properties, and then describe the resulting monoid for some examples.

This is joint work with João Araújo (U. Nova de Lisboa, NOVAMath), Wolfram Bentz (U. Aberta, NOVAMath), Janusz Konieczny (U. of Mary Washington), António Malheiro (U. Nova de Lisboa, NOVAMath), and Valentin Mercier (U. Nova de Lisboa, NOVAMath).

Eugenia Kochubinska *(Taras Shevchenko National University of Kyiv and Kyiv School of Economics)*

Tuesday 1 July, 11:45–11:54 • Room 122

Short Communications IV

Wreath product of monogenic inverse monoids

We consider the wreath power of a monogenic inverse monoid generated by a finite chain. We study the structure of this semigroup, focusing on certain combinatorial aspects and classical semigroup-theoretical concepts, such as the description of ideals and Green's relations. We show that there exists a unique irreducible generating set for the wreath power. This presentation is based on joint work with Andriy Oliynyk and Georgiy Shevchenko

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Cheng Yeaw Ku *(Nanyang Technological University)*

Tuesday 1 July, 14:30–15:00 • Room 103

Thematic Session: Groups 2

Continuos-time Quantum Walk on Cayley graph of the symmetric group.

The main object of study is the average mixing matrix whose columns encode the limiting distribution of the quantum walks from different starting vertices. We are particularly interested in the diagonal entries of this matrix for certain Cayley graph of the symmetric groups. This is joint work with Aw Wee Chong.

Dmitry Kudryavtsev *(University of York)*

Tuesday 1 July, 11:09–11:18 • Room 122

Short Communications IV

On semigroup properties respected by finitary approximations

A semigroup S is said to be locally embeddable into finite semigroups (an LEF semigroup, for short) if every finite subset of S with corresponding partial multiplication can be extended into a full finite semigroup. In this talk we will discuss the following question regarding this notion: if S has a given property X (e.g. being a cancellative semigroup, a group, an inverse semigroup, a solvable group, an E-unitary inverse semigroup, etc.), can we extend its finite subsets to finite semigroups which also share the property X? Furthermore, we will consider similar problems for other related embeddings and coverings.

Ganna Kudryavtseva *(University of Ljubljana)*

Monday 30 June, 14:30–15:00 • Room 106

Thematic Session: Inverse semigroups, restriction semigroups and related algebras

Generalizing Steinberg algebras to algebras of ample categories

We generalize a result by Steinberg and show that the contracted semigroup algebra K_0S of a restriction semigroup S with a restriction zero over a commutative ring with init K is isomorphic to the algebra $K(\mathcal{C}S)$ of the universal category $\mathcal{C}S$ of S. This also extends the result of Stein on algebras of left restriction and Ehresmann semigroups satisfying certain finitary conditions. We relate K_0S with the algebra of the universal and tight Booleanizations of S. The latter Booleanizations are analogues of similar notions for inverse semigroups considered by Lawson and Lenz and are Boolean restriction semigroups which, as follows from recent work by the author extending the result by Cockett and Garner for the unital case, are related to Boolean inverse semigroups similarly to as ample categories are related to ample groupoids.

Neeraj Kumar *(University of Porto)*

Tuesday 1 July, 11:27–11:36 • Room 122

Short Communications IV

Counting numerical semigroups and asymptotic Wilf's conjecture

We discuss the counting of numerical semigroups by their maximum primitive and Frobenius number, and show an equivalence between them through the Möbius function. We also discuss Wilf's conjecture and show that a numerical semigroup S with multiplicity m such that $|S \cap (m, 2m)| \geq \sqrt{3m}$ satisfies Wilf's conjecture. We further show that almost all numerical semigroups with large enough maximum primitive satisfy Wilf's conjecture.

Jung-Miao Kuo *(National Chung-Hsing University, Taiwan)*

Tuesday 1 July, 11:45–11:54 • Room 103

Short Communications I

Hirata separability, partial Galois extension and inner partial group action

We firstly review some Sugano's results on Galois extensions and then present our recent work generalizing Sugano's results in the context of partial group action. More explicitly, we give some equivalent conditions for partial Galois extensions to be Hirata-separable extensions and show that every partial Galois extension with inner partial group action is Hirata-separable.

Dimitri Leemans *(Université Libre de Bruxelles)*

Monday 30 June, 14:30–15:00 • Room 103

Thematic Session: Groups 1

Gluing methods for string C-group representations

The study of string C-group representations of rank at least $n/2$ for the symmetric group S_n has gained a lot of attention in the last fifteen years. In a recent paper, Cameron et al. gave a list of permutation representation graphs of rank $r \geq n/2$ for S_n, having a fracture graph and a non-perfect split. They conjecture that these graphs are permutation representation graphs of string C-groups. In trying to prove this conjecture, we discovered two new techniques to glue two CPR graphs for symmetric groups together. We discuss the cases in which they yield new CPR graphs. By doing so, we invalidate the conjecture of Cameron et al. We believe our gluing techniques will be useful in the study of string C-group representations of high ranks for the symmetric groups. This is joint work with Jessica Mulpas.

Henrique Leitão *(Universidade de Lisboa)*

Monday 30 June, 09:00–09:45 • Auditorium

Plenary Session I

Alentejo in Science: Scientific Discussions at the Badajoz-Elvas Border in 1524

TBA

Michael Levet *(College of Charleston, Department of Computer Science)*

Wednesday 2 July, 12:12–12:21 • Room 103

Short Communications V

Computational Complexity of Identifying Groups without Abelian Normal Subgroups

In this talk, I will discuss several advances in the computational complexity of identifying groups without Abelian normal subgroups (a.k.a. Fitting-free groups).

We will first consider the problem of computing the minimum faithful permutation degree, denoted $\mu(G)$, for Fitting-free groups. If G is given as a quotient of two permutation groups, we can compute $\mu(G)$ in polynomial-time. In the setting of permutation groups, we obtain a stronger bound of NC for this problem. This improves upon the work of Das and Thakkar (STOC 2024), who gave a Las Vegas polynomial-time algorithm for this class in the setting of permutation groups. On the other hand, we show that in the setting of permutation groups, isomorphism testing of Fitting-free groups is at least as hard as GRAPH ISOMORPHISM and LINEAR CODE EQUIVALENCE (the latter being GI-hard and having no known subexponential-time algorithm).

Lastly, we will consider the multiplication table model, where formal reductions from the general GROUP ISOMORPHISM problem to isomorphism testing of any specific sub-class of groups, remain elusive. Instead, we take as a complexity measure, the number of variables in a first-order (FO) formula without counting that identifies a given group uniquely up to isomorphism. We show that any Fitting-free group of order n is identified by FO formulas using only $O(\log \log n)$ variables. This is in contrast to the fact that there are infinite families of Abelian groups that are not identified by FO formulas using $o(\log n)$ variables (Grochow and Levet, FCT 2023).

This is joint work with Joshua A. Grochow, Dan Johnson, Pranjal Srivastava, and Dhara Thakkar.

Martin Liebeck *(Imperial College London)*

Wednesday 2 July, 09:00–09:45 • Auditorium

Plenary Session V

Fixed point spaces for actions of finite and algebraic groups

I will present some old and new results giving bounds for the sizes of fixed point spaces of elements of finite and algebraic groups G in their actions on various G-sets, G-modules and G-varieties. A guiding *motivation is an old conjecture of Peter Neumann that every non-regular primitive permutation group of degree n has an element g such that fix(g) is at least 1 and at most the square root of n.*

Adrian Lillo *(Universidad de Sevilla)*

Tuesday 1 July, 12:03–12:12 • Room 110

Short Communications III

Records on trees

Records of permutations (also known as left-to-right maxima) provide a rich source of combinatorial objects. They were shown to be counted by the Stirling numbers by Alfréd Rényi, and later given a combinatorial interpretation via Foata's fundamental transformation. We extend these results to trees, uncovering along the way some beautiful bijections and generating functions.

With is joint work with Mercedes Rosas and Stefan Trandafir.

Lia Malato *(Universidade de Aveiro)*

Tuesday 1 July, 12:03–12:12 • Room 103

Short Communications I

A *logical* future for algebra

Computers and machines have shaped the world since their invention. Although pure mathematics has often resisted the urge to integrate these advancements into its research, it is becoming increasingly clear that it can only grow stronger by embracing this new computational framework.

In this talk, I will present the next step in the evolution of algebra: the proof assistant Lean. Built on dependent type theory and the "Propositions As Types" paradigm, Lean forms a bridge between mathematical logic and algebra. A bridge that serves as an efficient and powerful tool for defining and reasoning about algebraic structures such as groups, rings and modules, and this with the power of logical precision.

Through original examples drawn from [1], I will show how algebra can benefit from this new perspective, a perspective in which proofs continue to have the elegancy of human-made proofs but gain robustness from the rigour of computer-verifiable proofs. Finally, I will hint at possible developments in proof writing, influenced by the use of artificial intelligence.

References: [1] Malato, Lia. On the Star Combinatory Calculus: formalization and applications to classical logic. Master's thesis, University of Lisbon, 2024. http://hdl.handle.net/10400.5/97265

Claude Marion *(Centro de Matemática da Universidade do Porto)*

Thursday 3 July, 14:30–15:00 • Room 103

Thematic Session: Groups 3

Finite and profinite groups with the Magnus Property

A group G is said to have the Magnus Property (MP) if whenever two elements $x, y \in G$ have the same normal closure, namely $\langle x\rangle^G = \langle y\rangle^G$, then x and y are conjugate or inverse-conjugate in G. In 1930 Magnus proved that every free group is MP. In the twenty first century, the study of groups with the Magnus Property gained some further interest. In this talk we investigate finite and profinite groups which are MP. This is based on joint works with Martino Garonzi and Pavel Zalesskii.

Filipe J. Marques *(NOVA University of Lisbon)*

Thursday 3 July, 11:44–12:06 • Room 106

Thematic Session: Advances in Inference and Modeling: formal and computational aspects

Tests for Complete Independence under Structured Covariance Assumptions

This work addresses the problem of testing for complete independence under specific covariance assumptions. We consider the likelihood ratio test (LRT) for complete independence, the LRT to test between the sphericity and compound-symmetry structures, and a chi-squared test, the latter of which can be used in high-dimensional scenarios. The properties of these tests are evaluated through a simulation study, with particular emphasis on bias and power. Furthermore, we study the reproducibility probability of these tests using a parametric bootstrap procedure.

Ursula Martin *(University of Oxford)*

Thursday 3 July, 12:00–12:30 • Room 122

Thematic Session: Automated Reasoning and the Future of Mathematical Practice

Will machines change mathematics?

A 2024 collection of articles in the Bulletin of the AMS asked "Will machines change mathematics?", suggesting that "Pure mathematicians are used to enjoying a great degree of research autonomy and intellectual freedom, a fragile and precious heritage that might be swept aside by a mindless use of machines." and challenging readers to "decide upon our subject's future direction." This talk will be a high-level, and possibly not entirely serious, approach to thinking about the factors, whether technical, social or economic, leading to the ongoing adoption, or otherwise, of computational interventions in mathematical practice, whether contemporary AI or 20th century computational group theory.

Nelson Martins-Ferreira *(Polytechnic of Leiria)*

Tuesday 1 July, 11:36–11:45 • Room 103

Short Communications I

On semibiproducts of semigroups and their magma-actions

A generalization to the categorical notion of biproduct, called semibiproduct, which in the case of groups covers classical semidirect products, has recently been analysed in the category of monoids with surprising results in the classification of weakly Schreier extensions. The purpose of this paper [1] is to extend the study of semibiproducts to the category of semigroups. However, it is observed that a further analysis into the category of magmas is required in attaining a full comprehension on the subject. Indeed, although there is a subclass of magma-actions, that we call representable, which classifies all semibiproducts of magmas whose behaviour is similar to semigroups, it is nevertheless more general than the subclass of associative magma-actions. [1] Martins-Ferreira, N. On semibiproducts of magmas and semigroups. Semigroup Forum 109, 574–596 (2024). https://doi.org/10.1007/s00233-024-10483-.

Ranjit Mehatari *(National Institute of Technology Rourkela, India)*

Tuesday 1 July, 11:36–11:45 • Room 106

Short Communications II

On P_4-free power graphs

Let G be a finite group. The power graph of G, denoted by $P(G)$, is a graph whose vertex set is G, and two vertices in $P(G)$ are connected by an edge if and only if one of them is a power of another. We start by going over some properties of power graphs. Then we characterize finite groups with no induced subgraphs isomorphic to a path on four vertices.

Đorđe Mitrović *(University of Auckland)*

Monday 30 June, 11:00–11:22 • Room 103

Thematic Session: Groups and Graphs

A new family of transitive permutation groups with exponential graph growth

Let Γ be a finite connected graph and G a vertex-transitive group of its automorphisms. The pair (Γ, G) is called locally-L if the permutation group induced by the action of the vertex-stabiliser G_v on the neighbourhood of a vertex v in Γ is permutation isomorphic to L. The maximum growth of $|G_v|$ as a function of $|V\Gamma|$ for locally-L pairs (Γ, G) is called the graph growth of L. In this talk, I will discuss a recent result showing that if a transitive permutation group L on a finite set Ω admits a proper block B such that the pointwise stabiliser of $\Omega \setminus B$ in L is non-trivial, then the graph growth of L is exponential. I will illustrate the impact of this new result by providing a survey on graph growth types of transitive permutation groups of low degree. This is joint work with Gabriel Verret.

Matevž Miščič *(Institute of Mathematics, Physics and Mechanics, Ljubljana)*

Wednesday 2 July, 11:54–12:03 • Room 106

Short Communications VI

Random Lie bracket on $\mathfrak{sl}_2(F_p)$

We study a random walk on the Lie algebra $\mathfrak{sl}_2(\mathbb{F}_p)$, where new elements are produced by randomly applying adjoint operators of two generators. We analyze the limiting distribution and convergence rate of this walk. With high probability, the walk exhibits a pre-cutoff phenomenon after approximately p steps. Furthermore, in the generic case, we demonstrate that the entire Lie algebra is covered in about $\log p$ steps. This is joint work with Urban Jezernik.

Ana Catarina Monteiro *(NOVA University of Lisbon)*

Thursday 3 July, 11:22–11:44 • Room 110

Thematic Session: Conjugacy and Induced actions in groups, semigroups, and automata

Product of Formations of Congruences on Groups

In this talk, we focus on formations of groups and formations of congruences on groups. A formation of groups is a class of groups closed under quotients and subdirect products of finite families. A formation of congruences on groups is a correspondence that assigns to each group G, a set of congruences on G satisfying certain closure properties.

Various definitions for the product of classes of groups have been proposed and studied, particularly with regard to the preservation of structural properties such as being a formation [1].

Recent developments have extended these ideas to the level of congruences and languages on groups, leading to the introduction and study of formations of congruences and formations of languages [2, 3, 4].

These developments naturally raise the question: How should we define the product of formations of congruences and languages in a way that preserves desirable algebraic properties?

In this talk, we explore this question in the context of groups and discuss potential generalizations to other algebraic structures, such as Clifford semigroups and inverse semigroups.

This is joint work with Gracinda Gomes.

References [1] K. Doerk and T. Hawkes (1992), Finite Soluble Groups, Walter de Gruyter. [2] G. Gomes and A.-C. Monteiro (2024), "Formations and i-Fitting classes of inverse semigroups, congruences and languages", Semigroup Forum 109, 87–115. [3] M. Ballester-Bolinches, J.-E. Pin, and X. Soler-Escrivà (2015), "Languages associated with saturated formations of groups," Forum Mathematicum, 27(3):1471–1505. [4] A. Ballester-Bolinches, E. Cosme Llópez, R. Esteban-Romero, and J. Rutten (2015), "Formations of monoids, congruences, and formal languages," Scientific Annals of Computer Science, 25:171–209.

Alessandro Montinaro *(Università del Salento)*

Tuesday 1 July, 11:54–12:03 • Room 106

Short Communications II

The Higman-McLaughlin Theorem for the flag-transitive 2-designs with λ prime

A 2-(v, k, λ) design $\mathcal{D}$ *is a pair* $(\mathcal{P}, \mathcal{B})$ *with a set* $\mathcal{P}$ *of* v *points and a set* $\mathcal{B}$ *of blocks such that each block is a* k*-subset of* $\mathcal{P}$ *and each two distinct points are contained in exactly* λ *blocks. An automorphism of* $\mathcal{D}$ *is a permutation of the point set which preserves the block set. The set of all automorphisms of* $\mathcal{D}$ *with the composition of permutations forms a group, denoted by* $\mathrm{Aut}(\mathcal{D})$*. For a subgroup* G *of* $\mathrm{Aut}(\mathcal{D})$*,* G *is said to be* point-primitive *if* G *acts primitively on* $\mathcal{P}$*, and said to be* point-imprimitive *otherwise. A* flag *of* $\mathcal{D}$ *is a pair* (x, B) *where* x *is a point and* B *is a block containing* x*. If* $G \leq \mathrm{Aut}(\mathcal{D})$ *acts transitively on the set of flags of* $\mathcal{D}$*, then we say that* G *acts* flag-transitively *on* $\mathcal{D}$*.*

A famous result of Higman and McLaughlin [2] in 1961 asserts that, if G *acts flag-transitively on* $\mathcal{D}$ *and* $\lambda = 1$ *then* G *acts point-primitively on* $\mathcal{D}$*. Since then, several authors investigated under which conditions either on* $\mathcal{D}$ *or* G*, the previous implication still holds true when* $\lambda > 1$*. Recently, Devillers and Praeger [1] showed that the Higman-McLaughling theorem can be extended to the case* $\lambda \leq 4$ *except for* $v \in \{15, 16, 36, 45, 96\}$ *and* $\mathcal{D}$ *is isomorphic to eleven specific* 2*-designs.*

In my talk, which is based on the results contained in [3], I show that the conclusion of the Higman-McLaughling theorem still holds true when λ *is a prime number except when either* $\mathcal{D}$ *is a specific* 2*-design with parameters* $(v, k, \lambda) = (16, 6, 2)$ *or* $(45, 12, 3)$*, or* λ *is a Fermat prime greater than* 5 *and* $\mathcal{D}$ *is a possible a* 2-$((\lambda-1)^2(\lambda+1), \lambda(\lambda-1), \lambda)$ *design.*

References

[1] *A. Devillers, C. E. Praeger, On flag-transitive point-imprimitive* 2*-designs, J. Comb. Des.* ***29*** *(2021) 552-574.*

[2] *D. G. Higman and J. E. McLaughlin, Geometric ABA-groups, Illinois J. Math.* ***5*** *(1961) 382–397.*

[3] *A. Montinaro, The Higman-McLaughlin Theorem for the flag-transitive* 2*-designs with* λ *prime, arXiv:2504.11407*

Francisco Loureiro da Silva Mendes Moreira *(CEMS.UL/FCUL)*

Wednesday 2 July, 12:12–12:21 • Room 122

Constructing supercharacter theories for inverse semigroups

Supercharacter theories for groups is a topic that has been studied over the years, with supercharacter theories on finite groups being well defined. The goal of this presentation is to show that it is possible to construct a supercharacter theory for inverse semigroups in a simple (although extremely rudimentary) way, using the relation between an inverse semigroup, its maximal subgroups, and the supercharacter theories in each of these maximal subgroups. The presentation will also touch on the subject of Schur rings, and how the construction presented for inverse semigroups keeps the relation between supercharacter theories and Schur rings that is present in the finite group case.

Carlos Jesús Moreno *(Universidad de Extremadura)*

Thursday 3 July, 15:20–15:40 • Room 106

Thematic Session: Commutative Monoids

Numerical semigroups linked to curves with only one place at infinity

Let C be a curve on $\mathbb{P}^2$ with only one place at infinity at a point $p \in \mathbb{P}^2$, and let $S_{C,\infty}$ be its semigroup at infinity, i.e. the additive submonoid of $(\mathbb{N}, +)$ consisting of the orders —with negative sign— of the poles of the regular functions around (but not in) p. After a theorem by Abhyankar and Moh, we can associate to C a so-called δ-sequence in $\mathbb{N}_{>0}$ which is a system of generators of $S_{C,\infty}$, by no means unique.

Curves with only one place at infinity are relevant, for instance they play an important role in the study of the Jacobian conjecture. However, not so much is known about $S_{C,\infty}$ from a combinatorial point of view. In this talk we review the previous concepts and results and we see some properties of the δ-sequences; in particular, we introduce the notion of minimal δ-sequence as that generated only by the minimal elements of the semigroup at infinity. In addition, we show how we can compute the remaining δ-sequences associating with the same semigroup at infinity. Finally, we see algorithm procedures to compute minimal δ-sequences.

[1] This talk is based on a joint work with C. Galindo, F. Monserrat and J.-J. Moyano-Fernández. The authors were partially funded by MCIN/AEI/10.13039/501100011033 and by "ERDF A way of making Europe", grant PID2022-138906NB-C22, as well as by Universitat Jaume I, grant GACUJIMA-2024-03. The speaker was also supported by the Margarita Salas postdoctoral contract MGS/2021/14(UP2021-021) financed by the European Union-NextGenerationEU.

José Navarro *(Universidad de Extremadura)*

Thursday 3 July, 15:40–16:00 • Room 106

Thematic Session: Commutative Monoids

Exploring Toric Varieties with Condensed Mathematics: some open problems

Affine toric varieties are central objects in algebraic geometry, with their structure deeply encoded by the combinatorics of their semigroup of characters. When we consider these varieties over general topological fields K (like $\mathbb{R}$, $\mathbb{C}$, $\mathbb{Q}_p$, $\mathbb{C}_p$, or $\mathbb{F}_q((t))$), their K-points exhibit rich and often complicated analytic and topological structures that go beyond the purely algebraic picture.

Condensed mathematics, a new framework recently developed by Dustin Clausen and Peter Scholze, offers a powerful lens to study such topological-algebraic objects. By replacing topological spaces with 'condensed sets' (sheaves on a site of profinite sets), it provides categories with better formal properties, particularly suited for analytic geometry over topological fields.

This talk will provide a brief, non-technical introduction to the motivation and core ideas behind condensed mathematics, aimed at toric geometers. We will then briefly explore some open problems related to understanding affine toric varieties through this new perspective, such as the computation of condensed cohomology and its relation to known invariants.

This work has been funded at 85% by the European Union, European Regional Development Funds, Junta de Extremadura, Autoridad de Gestión and Ministerio de Hacienda, through project GR24068. It has also been partially funded by project PID2022-142024NB-I00.

Daniele Nemmi *(University of Padova)*

Monday 30 June, 15:00–15:30 • Room 103

Thematic Session: Groups 1

Graphs encoding generating properties of finite groups

We are going to explore some graphs related to the generation of finite groups, with a particular attention to their connection with almost simple groups.

Eamonn O'Brien *(University of Auckland)*

Wednesday 2 July, 09:45–10:30 • Auditorium

Plenary Session V

Challenging problems for matrix groups

Significant progress has been achieved in developing high-quality algorithms to answer questions about matrix groups defined over finite fields. But major challenges remain. I will report on the progress and discuss some of these difficult problems.

Ori Parzanchevski *(The Hebrew University of Jerusalem)*

Thursday 3 July, 15:00–15:30 • Room 103

Thematic Session: Groups 3

Bounded cutoff on matrix groups

Answering a question of Sarnak, we construct an explicit set of generators for the groups PSL(n,q) for which the random walk exhibits total-variation cutoff with bounded window size (namely, independent of q). The construction makes use of geodesic flows on Bruhat-Tits buildings, automorphic representation theory in positive characteristic, and spectral analysis of almost-normal operators.

Tânia Paulista *(NOVA University of Lisbon & NOVA Math)*

Wednesday 2 July, 12:03–12:12 • Room 122

Short Communications VIII

Commuting graph of a 0-Rees matrix semigroup over a group

The commuting graph of a finite non-commutative semigroup S *is a simple graph whose vertices are the non-central elements of* S*, and where two distinct vertices* $x, y \in S$ *are adjacent if and only if* $xy = yx$*.*

We study the commuting graph of a 0-Rees matrix semigroup over a group, and determine some of the properties of this graph (for example, connectedness, diameter, clique number, chromatic number and girth).

The interest of studying 0-Rees matrix semigroups over groups is justified by the Rees—Suschkewitsch theorem, which provides a characterization of completely 0-simple semigroups. This way, studying the commuting graph of a 0-Rees matrix semigroup over a group supplies information regarding the properties of commuting graphs of completely 0-simple semigroups.

Soňa Pavlíková *(Slovak University of Technology, Bratislava, Slovakia)*

Tuesday 1 July, 11:27–11:36 • Room 110

Short Communications III

Spectral indices of signable Moore-Penrose inverses of graphs

The Moore-Penrose inverse of a simple graph G *is the edge-labeled graph* G^{-1} *determined by the Moore-Penrose inverse* $M(A_G)$ *of the adjacency matrix* A_G *of the original graph. We will focus on simple graphs* G *for which* $M(A_G)$ *is a signable matrix, that is, diagonally similar to a non-negative or a non-positive matrix, turning the edge-labeled graph* G^{-1} *into a graph with all edge-labels non-negative (non-positive). This approach represents a generalization of the classical concept of positive integral invertibility of graphs, introduced by C. Godsil in 1981.*

In the talk we will present a mixture of theoretic and computational results on properties of graphs admitting a signable Moore-Penrose inverse. Particular interest will be given to extreme values of the so-called spectral indices, which are invariants derived from graph spectra that have applications in theoretical and computational chemistry.

The author acknowledge research support from APVV Research Grant 22-0005.

Ignacio M. Pelayo *(Universitat Politècnica de Catalunya (Barcelona, Spain))*

Tuesday 1 July, 11:36–11:45 • Room 110

Short Communications III

THE PROBLEM OF RECONSTRUCTING A GRAPH FROM ITS BOUNDARY DISTANCE MATRIX

A vertex v of a connected graph G is said to be a boundary vertex of G if for some other vertex u of G, no neighbor of v is further away from u than v. The boundary $\partial(G)$ of G is the set of all of its boundary vertices.

The boundary distance matrix $\hat{D}_G$ of a graph $G = ([n], E)$ is the square matrix of order κ, being κ the order of $\partial(G)$, such that for every $i, j \in \partial(G)$, $[\hat{D}_G]_{ij} = d_G(i, j)$.

In a recent paper [doi.org/10.7151/dmgt.2567], it was shown that if a graph G is either a block graph or a unicyclic graph, then G is uniquely determined by the boundary distance matrix $\hat{D}_G$ of G and it was also conjectured that this statement holds for every connected graph G, whenever both the order n and the boundary (and thus also the boundary distance matrix) of G are prefixed.

After proving that this conjecture is true for several graph families, such as being of diameter 2, having order at most $n = 6$ or being Ptolemaic, we show that this statement does not hold when considering, for example, either the family of split graphs of diameter 3 and order at least $n = 10$ or the family of distance-hereditary graphs of order at least $n = 8$.

Claudio Alexandre Piedade *(Centro de Matemática da Universidade do Porto, Portugal)*

Tuesday 1 July, 12:21–12:30 • Room 106

Short Communications II

Merging Coset Geometries: Split extensions and Twistings

Incidence geometries are in the basis of Tits buildings and related structures. Coset incidence systems are incidence structures derived from group cosets, where points, lines, and higher-dimensional elements correspond to cosets of certain subgroups. These capture symmetry and combinatorial properties of groups, particularly in relation to buildings and flag complexes.

In a project with Philippe Tranchida, we study how various standard operations on groups can be extended to operations on coset geometries, such that properties like flag-transitivity and residually connectedness are preserved.

In this talk, we will describe two distinct ways of building a coset incidence system by split extension. One of these constructions is inspired by the twisted simple groups, preserving the thinness of the original coset incidence systems. This allows us to apply this construction to polytopes and hypertopes, generalising the known twisting operation of polytopes [1].

[1] McMullen, Peter, and Egon Schulte. Abstract regular polytopes. Vol. 92. Cambridge University Press, 2002.

Cheryl E Praeger *(University of Western Australia)*

Wednesday 2 July, 14:00–14:45 • Auditorium

Plenary Session VII

(The Fun of) Working with Peter

I am one of many who have enjoyed the fun of working with Peter Cameron. And I am Super-happy to have this opportunity to wander through the story of our mathematical collaborations. Although Peter and I were born in the same town in South East Queensland, I did not meet Peter until I reached Oxford as a DPhil student. Our first joint maths project dates back to the announcement finite simple group classification, and working jointly has continued for 45 years. Speaking with Peter leads to "all kinds of new ideas".

C. Correia Ramos *(Departamento de Matemática, CIMA, Universidade de Évora)*

Wednesday 2 July, 11:45–11:54 • Room 106

Short Communications VI

Algebraic invariants for discrete dynamical systems

We describe algebraic structures defined on discrete dynamical systems that remain invariant under topological equivalence. In particular, we consider the commutative semigroups associated with periodic orbits of Markov systems. Every Markov topological chain naturally corresponds to a Markov interval map, therefore, these semigroups can also be defined for a specific class of iterated interval maps. We identify the types of interval maps for which these semigroups are numerical semigroups and introduce several parameterized families, establishing the relationship between their algebraic and dynamical parameters.

Catherine Reilly *(University of East Anglia (UEA))*

Tuesday 1 July, 11:54–12:03 • Room 122

Some decidability results for one-relator inverse monoids with two generators

Recent results have shown that there are one-relator inverse monoids with undecidable word problem. The constructions used to establish those results always result in examples of inverse monoids with at least three generators. A result from group theory tells us that every finitely generated n-relator group embeds into an n-relator group with two generators. The techniques used in that proof for groups fail immediately when we consider special inverse monoids. Nevertheless, here I will present new results that show how one can construct 2-generator one-relator inverse monoids with undecidable word problem, building on results by Gray.

Kamilla Rekvényi *(University of Manchester)*

Tuesday 1 July, 14:00–14:30 • Room 103

Thematic Session: Groups 2

Prime Simplicial Complexes of Finite Groups

In 2024, Peter Cameron proposed generalisations of various graphs defined on groups to simplicial complexes. I will talk about one of these, the prime simplicial complex $\Pi(G)$ of a finite group G, which is composed of all sets of primes S where G has an element of order the product of primes in S, with the subsets partially ordered by inclusion. This is a generalization of the well-studied prime (or Gruenberg-Kegel) graphs. I will present new results about recognizability by prime simplicial complex, and the purity of the prime simplicial complex, a question asked by Peter Cameron. Joint work with Melissa Lee.

Fernando Martin-Maroto and Antonio Ricciardo *(Champalimaud Foundation and Algebraic AI)*

Monday 30 June, 14:00–16:00 • Room 110

Thematic Session: Algebra and Machine Learning

How Algebra can help Machine Learning

Subdirect decomposition offers an algebraic foundation for machine learning, presenting a compelling alternative to traditional statistical methods. We will give a comprehensive introduction to Algebraic Machine Learning (AML), an approach that leverages subdirect decomposition to solve regression and classification tasks, with accuracy comparable to multilayer perceptrons. Moreover, it has the unique feature of being able to learn to solve complex combinatorial problems—such as Hamiltonian cycle detection—directly from problem descriptions.

We will give an introduction to the AML framework, comprehending an introduction to atomized semilattices, a mathematical representation tool for semilattices at the core of AML, and showcase the example of solving the Hamiltonian cycle problem.

José Luis Vilca Rodríguez *(Universidade de São Paulo)*

Monday 30 June, 15:30–16:00 • Room 106

Thematic Session: Inverse semigroups, restriction semigroups and related algebras

Inverse semialgebras

We introduce the notion of an inverse semialgebra, both associative and Lie, and provide illustrative examples of these structures. Furthermore, we present several results, including, in particular, an analogue of the characterization of F-inverse semigroups as crossed products, adapted to the setting of Lie inverse semialgebras.

This is a part of a joint work with M. Dokuchaev and F. Johari.

Colva Roney-Dougal *(University of St Andrews)*

Wednesday 2 July, 14:50–15:35 • Auditorium

Plenary Session VII

Bases and relational complexity

Let G be a permutation group on a set Ω. An irredundant base *for G is a sequence $(\omega_1, \ldots, \omega_b)$ of elements of Ω such that the corresponding sequence of point stabilisers satisfies*

$$G > G_{\omega_1} > G_{\omega_1,\omega_2} > \cdots > G_{\omega_1,\ldots,\omega_b} = 1.$$

There is an unexpected connection to model theory, via the notion of relational complexity. *Informally speaking, the relational complexity of G measures the extent to which local information about the action* *of elements of G determines global information. This talk will be a survey of these two areas, both of which have a very Cameron-esque flavour.*

Gordon Royle *(University of Western Australia)*

Tuesday 1 July, 09:45–10:30 • Auditorium

Plenary Session III

Cubic graphs and spectral gap sets

Spectral graph theory is the study of the relationship between the graphical properties of a graph and the spectral properties (i.e., eigenvalues and eigenvectors) of one of the various matrices associated with that graph, most commonly the adjacency matrix. The spectrum of the adjacency matrix of a cubic graph (i.e., one where each vertex has three neighbours) on n vertices is a set of n real numbers lying in the interval [-3,3] and it determines a surprising amount of information about the graph. A spectral gap set is an open subset X of (-3,3) with the property that there are an infinite number of cubic graphs whose spectrum is disjoint from X. For example, the interval (-3,-2) is a spectral gap set because the infinite family of cubic line graphs has no eigenvalues in (-3,-2), and in fact the precise list of all cubic graphs whose spectrum avoids (-3,-2) is known. Krystal Guo and Bojan Mohar showed that the interval (-1,1) is a spectral gap set for cubic graphs, and recently Alicia Kollár and Peter Sarnak demonstrated the same result for (-2,0) and in addition showed that any spectral gap interval has length at most 2. In this talk I describe some recent work, joint with Krystal Guo, where we give exact characterisations of the cubic graphs with spectra avoiding (-1,1) and those with spectra avoiding (-2,0). These exact characterisations allow us to deduce that (-1,1) is a maximal spectral gap set, thereby answering a question of Kollár and Sarnak. The talk is largely non-technical and should be accessible to anyone familiar with basic graph theory and linear algebra.

Nik Ruskuc *(University of St Andrews)*

Tuesday 1 July, 16:30–17:15 • Auditorium

Plenary Session IV

Heights of congruence lattices of semigroups

The height of a (finite) lattice L is the size of a maximum chain in L. Cameron, Solomon and Turull (1989) showed that the height of the subgroup lattice of the symmetric group S_n is given by $\lceil 3n/2 \rceil - b(n)$, where b(n) is the number of 1s in the binary expansion of n. The analogue of S_n for semigroups is the full transformation semigroup T_n. Cameron, Gadoleau, Mitchell and Perese (2017) established an accurate asymptotic formula for the height of the subsemigroup lattice of T_n. But the subgroup lattice of a group G can be viewed from a different angle: it is (isomorphic to) the lattice of right (or left) congruences of G.(And one-sided congruences of a monoid are in a 1-1 correspondence with cyclic transformation representations of S.) In this talk I will introduce a general method which gives a lower bound for the height of the lattices of one- or two-sided congruences of an arbitrary semigroup, and under certain additional conditions gives the exact values. I will apply this theory to obtain the height for the lattices of right and left congruences of T_n, as well as for many other natural semigroups of transformations, partitions and matrices. This is joint work with Matthew Brookes, James East, Craig Miller and James Mitchell.

Andrew Ryzhikov *(University of Warsaw, Poland)*

Wednesday 2 July, 11:45–11:54 • Room 110

Short Communications VII

Free hulls and decompositions of codes: old results, new open problems

Let Σ_1, Σ_2 be two finite alphabets, and let Σ_1^*, Σ_2^* be the free monoids generated by them. A code *is a homomorphism from Σ_1^* to Σ_2^*. Representing a code as a composition of simpler codes is a powerful technique in analysing its properties, such as the group and the degree of a code. For constructing a decomposition of a code, it is often useful to consider free hulls of subsets of Σ_1^*.* The free hull *of a set $S \subseteq \Sigma_1^*$ is the minimal free submonoid of Σ_1^* containing S. A result from 1979 by J. Berstel, D. Perrin, J.-F. Perrot and A. Restivo shows that the free hull of a regular set is always regular, and can be effectively constructed. I will discuss the computational complexity of this problem and its special cases, and explain what implications it has for code decompositions. I will also discuss the case of prefix codes. The talk is based on the work-in-progress with Francesco Dolce.*

Luca Sabatini *(University of Warwick)*

Tuesday 1 July, 11:18–11:27 • Room 106

Short Communications II

Breaking symmetry of permutation groups

Let G be a permutation group on the finite set Ω. One of the most studied topics in permutation group theory is finding a partition of Ω whose stabilizer is trivial. In this talk we fix only the bare minimum (so one subset, or a pair of points) and we do not aim to find a trivial stabilizer, since this would be impossible in general, but to find a stabilizer that has at least some good properties. In doing so, we will answer some questions of Babai and give an easier proof of a theorem of Cameron.

Carlos M. Saiago *(Universidade NOVA de Lisboa)*

Tuesday 1 July, 11:18–11:27 • Room 110

Short Communications III

Fundamental Graphs for the Maximum Multiplicity Eigenvalue

Let G be a simple undirected graph and $\mathcal{H}(G)$ be the set of Hermitian matrices whose graph is G. We denote by $maxMult(G)$ the maximum multiplicity that occurs for any eigenvalue of any matrix in $\mathcal{H}(G)$. For a given graph G, natural questions arise about the possible status of a particular vertex of G (as Parter*,* neutral *or* downer*) for an eigenvalue achieving $maxMult(G)$.*

The main focus of this talk is the "fundamental graphs" (cf. [1]) for the maximum multiplicity problem of eigenvalues among Hermitian matrices associated with a given undirected simple graph. A graph G is a fundamental *graph if whenever $maxMult(G)$ is attained by an $A \in \mathcal{H}(G)$, then the corresponding eigenvalue has no Parter vertices. Along the way we explicitly identify all unicyclic fundamental graphs, cf. [2].*

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[1] C.R. Johnson, A. Leal-Duarte, and C.M. Saiago. Fundamental graphs for the maximum multiplicity of an eigenvalue among Hermitian matrices with a given graph. Advances in Operator Theory *10(30) 1–8 (2025). [2] C.R. Johnson and A. Leal-Duarte. The maximum multiplicity of an eigenvalue in a matrix whose graph is a tree.* Linear and Multilinear Algebra *46:139–144 (1999).*

Jacques Sakarovitch *(LTCI, Télécom Paris, Institut Polytechnique de Paris)*

Thursday 3 July, 11:44–12:06 • Room 110

Thematic Session: Conjugacy and Induced actions in groups, semigroups, and automata

The computational aspect of equivalence of weighted automata

The theoretical framework for the decidability of equivalence of finite automata with weights in a semiring K is based on the notion of conjugacy of weighted automata, a concept borrowed to symbolic dynamics. Two conjugate automata are obviously equivalent, but the remarkable fact is that the converse almost holds: two equivalent automata are conjugate to a third one in all known cases where the equivalence is decidable. The decision algorithm for the equivalence of the automata A and B amounts indeed to the computation of that third automaton C that is conjugate to A and B. We'll briefly sketch the general structure of the algorithm and the distinctive features in the cases where the weight semiring is a division ring, a principal ideal domain, a commutative ring, and a bounded distributive lattice. Joint work with Marie-Pierre Béal and Sylvain Lombardy.

Jamie Smith *(University of York)*

Tuesday 1 July, 11:00–11:09 • Room 106

Short Communications II

The endomorphism tower problem for the symmetric group

Significant effort has been devoted to studying endomorphisms of natural algebraic objects, with the resulting monoids often serving as concrete foundations for theoretical development. A classic example is the endomorphism monoid of a set - known as the full transformation monoid.

Much of the existing work focuses on endomorphism monoids End(A) of independence algebras A (a set may be viewed as an independence algebra). There is now growing interest in understanding the *endomorphisms of the resulting monoids End(A), and indeed of other monoids. Even in the cases where the endomorphisms themselves were known their interactions had not been considered.*

We denote by End(M) the endomorphism monoid of a monoid M. Recent work by Gould, Grau, and Johnson investigated End($\mathcal{T}_n$) and revealed a surprisingly unfamiliar structure. Motivated by the group-theoretic automorphism tower problem, we consider analogous sequences of endomorphism monoids: M, End(M), End(End(M)), and so on. What patterns, if any, emerge in such sequences?

We refer to this as the endomorphism tower problem. This talk will explore this problem in the context of the symmetric group $\mathcal{S}_n$.

Terry Speed *(Walter and Eliza Hall Institute of Medical Research)*

Monday 30 June, 11:00–11:30 • Auditorium

Thematic Session: Design of Experiments: Mathematical, Computational and Statistical Aspects

Removing unwanted variation using design of experiments: 1925-2025.

TBA

Pablo Spiga *(University of Milano-Bicocca)*

Monday 30 June, 16:30–17:15 • Auditorium

Plenary Session II

Kronecker classes, Isbell's conjecture and derangement graphs

A derangement is a permutation with no fixed points — a simple concept with implications in group theory and beyond. A normal covering of a finite group G is a collection of proper subgroups $H_1, \ldots, H_\ell$ such that every element of G lies in a conjugate of one of the H_i. In this talk, we explore some interplays between derangements, normal coverings, and Kronecker classes in algebraic number fields. Along the way, we present a series of open questions and show how problems in permutation group theory, derangement graphs, and algebraic number theory are connected.

Nóra Szakács *(University of Manchester)*

Tuesday 1 July, 15:00–15:30 • Room 110

Thematic Session: Geometric and combinatorial (inverse) semigroup theory 2

Inverse semigroups with bounded group distortion

Given an inverse semigroup S, the maximal group morphism from S to S/σ induces maps from the Schützenberger graphs of S to the Cayley graph of S/σ, which are injective when the inverse semigroup is E-unitary. We consider how these embeddings distort the distance function on the Schützenberger graphs and call this the group distortion of S. We are motivated by the following questions: if the group distortion is sufficiently nice (e.g. recursively bounded, or linearly bounded, or even an isometry), does that imply a solvable word problem in S? And: what conditions can we impose on S to ensure that the group distortion is sufficiently nice? We will show that much of what one would hope for fails, but will also present some positive results. This is based on joint work with Mark Kambites.

Raquel Tapia-Ramos *(Universidad de Cádiz)*

Thursday 3 July, 15:00–15:20 • Room 106

Thematic Session: Commutative Monoids

An approach to ideals of affine semigroups and MED-semigroups

A subset P of an affine semigroup S is an ideal of S if $P + S \subseteq P$. This talk, based on the work presented in [1], focuses on the study of ideals of affine semigroups, providing characterizations and developing algorithms to compute all ideals that are also affine semigroups satisfying certain properties. Special emphasis is given to affine semigroups with maximal embedding dimension (MED-semigroups), which are defined by the unique property that all elements in the intersection of their Apéry sets, excluding zero, are minimal generators of S.

This work is a collaboration with J.I García-García and A. Vigneron-Tenorio. The author is partially supported by the project ProyExcel_00868.

[1] García-García, J. I.; Tapia-Ramos, R.; Vigneron-Tenorio, A.: On ideals of affine semigroups and affine semigroups with maximal embedding dimension. *Open Mathematics (2024) 22, no. 1: 20140101. (https://doi.org/10.48550/arXiv.2405.14648)*

Philippe Tranchida *(Max Planck Institute for Mathematics in the Sciences)*

Tuesday 1 July, 12:12–12:21 • Room 106

Short Communications II

Merging Coset Geometries: Free Amalgamated Products and HNN-extensions

In 1956, Jacques Tits introduced the concept of coset geometries, which later became a fundamental tool in his theory of buildings. Starting from a group G and a system $(G_i)_{i \in I}$ *of subgroups of G, coset geometries produce a space (an incidence geometry) on which G acts naturally. In fact, Tits showed that, in some sense, every interesting spaces related to G (i.e: incidence geometries on which G acts flag-transitively) can be constructed this way.*

In a project with Claudio Piedade, we study how various "merging" operations on groups can be extended to operation on coset geometries in a way that preserves properties such as flag-transitivity or residual connectedness. By doing so, we show that these operations extend to the incidence geometries on which the groups act in a satisfying way. In this talk we will focus on free amalgamated products and HNN-extensions, the two fundamental operations of Bass-Serre theory. We hope that further work on this subject will make the connection with Bass-Serre theory stronger.

Rustam Turdibaev *(New Uzbekistan University)*

Wednesday 2 July, 12:03–12:12 • Room 106

Short Communications VI

Noncommutative Poisson structure and invariants of matrices

We develop a new algorithm based on noncommutative Poisson geometry to investigate the algebra of invariants of pairs of square matrices under simultaneous conjugation. Using this approach, we provide a complete solution to the long-standing problem of finding all defining relations for the algebra of invariants of two 4 by 4 matrices. Starting from the minimal generating set described by Drensky and Sadikova, we determine the full set of relations in the algebra of invariants of two matrices of size 4 without limiting ourselves to relations of a fixed degree. By leveraging the Poisson structure, our method enables the systematic construction of higher-degree relations from lower-degree ones, resulting in an efficient computation that concludes at degree 16 - even though the highest-degree relation appears in degree 20. Remarkably, we demonstrate that just 8 Poisson-derived relations are sufficient to generate the associative ideal of 105 defining polynomials.

Coen del Valle *(University of St. Andrews)*

Thursday 3 July, 14:00–14:30 • Room 103

Thematic Session: Groups 3

Cameron's Greedy Conjecture

Let G be a group of permutations of a finite set Ω*. A base for G is a subset of* Ω *whose pointwise stabiliser is trivial; denote the size of a smallest base for G by* $b(G)$*. There is a natural greedy algorithm for finding a base of relatively small size. In 1999, Peter Cameron conjectured that for G primitive, this algorithm produces bases of size at most some absolute constant multiple of* $b(G)$*. In this talk, we will explore recent progress towards settling this conjecture.*

Justin Vast *(UCLouvain)*

Tuesday 1 July, 12:03–12:12 • Room 106

Short Communications II

BMW groups

*A **BMW group** is a group* Γ *that acts freely and transitively on the Cartesian product of two (regular) trees* $T_1 \times T_2$*. The class of BMW groups is very rich: It contains not only products of virtually free groups but also certain arithmetic groups and some finitely presented virtually simple groups, among many others.*

The present talk aims to explain how the finite quotients of Γ *and its local actions help to understand the group and how that knowledge can prove or disprove its irreducibility or arithmeticity.*

Alberto Vigneron-Tenorio *(Universidad de Cádiz)*

Thursday 3 July, 14:40–15:00 • Room 106

Thematic Session: Commutative Monoids

Generalisation of some results for numerical semigroups to affine semigroup

Strong numerical semigroups are introduced in [1]: a numerical semigroup S is strong if $x+y-m(S) \in S$ for all $x, y \in S$ such that $x \not\equiv y \mod m(S)$, where $m(S)$ is the multiplicity of S.

In this talk we generalize this concept to affine semigroups and focuses on some main similarities and differences between strong numerical semigroups and strong affine semigroups. Some results on strong affine semigroups are shown.

This ongoing work began during a research visit by Raquel Tapia-Ramos (Universidad de Cádiz) and Alberto Vigneron-Tenorio to University of Évora in February 2025.

[1] Robles-Pérez, A. M.; Rosales, J. C., Modular Frobenius pseudo-varieties*, Collect. Math. 74 (2023), 133–147.*

Mikhail V. Volkov *( )*

Tuesday 1 July, 09:00–09:45 • Auditorium

Plenary Session III

Completely Reachable Automata: an interplay between (semi)groups, finite automata, and binary trees

A finite automaton is called completely reachable if every non-empty set of states arises the image of a certain sequence of input signals. Complete reachability is a strengthening of the well-known property of synchronizability. We overview recent results on completely reachable automata, with an emphasis on connections to the theory of permutation groups.

Jan Philipp Wächter *(University of Manchester)*

Tuesday 1 July, 14:30–15:00 • Room 110

Thematic Session: Geometric and combinatorial (inverse) semigroup theory 2

Maximal subgroups of special inverse monoids 2

A monoid is called special if it admits a monoid presentation where all relations are of the form $w = 1$. Accordingly, the class of special monoids includes all groups. However, the connection between special monoids and groups is much deeper as they inherit many properties from their group of units. One example for this phenomenon is that the word problem of a special monoid is decidable if and only if the one of its unit group is (Makanin). This immediately yields that also the word problems of all other subgroups of the special inverse monoid are decidable. In fact, Malheiro showed that all maximal (w.r.t. set inclusion) subgroups are isomorphic to the group of units, underlining how much the structure of the monoid is dominated by its group of units.

Analogously to special monoids, we may also consider special inverse monoids (which admit an inverse monoid presentation where all relations are of the form $w = 1$). From an algorithmic perspective, special inverse monoids are interesting since the word problem for one-relator monoids (i.e. monoids admitting a presentation with a single relation $u = v$) reduces to the word problem for one-relator special inverse monoids (Ivanov, Margolis and Meakin). One would hope that the structure of special inverse monoids is similarly dominated by the group of units as in the non-inverse case. Indeed, for the class of E-unitary special inverse monoids, Gray and Kambites showed that every maximal subgroup is virtually embeddable in the group of units (i.e. has an embeddable finite index subgroup). Outside the realm of E-unitary inverse monoids, however, this is far from true: we will show a construction that yields any finitely presented group (even one with an undecidable word problem) as a maximal subgroup of a special inverse monoid with a trivial group of units. We will also discuss techniques for showing this result.

This is joint work with Robert Gray and Mark Kambites.

Yayi Zhu *(University of St Andrews)*

Wednesday 2 July, 11:45–11:54 • Room 122

Short Communications VIII

Relational depth of transformation semigroups

Presentations for classical transformation semigroups have long been of interest, including the partial transformation semigroup PT_n, the symmetric inverse monoid I_n, and the full transformation semigroup T_n. Green's J-relation partitions those semigroups into subsets consisting of (partial) transformations of a certain rank, and the J-classes form a chain. We are interested how far down the chain must every presentation reach, and we use the notion of 'depth' to describe this. In this talk, I will present results on the relational depth of PT_n, I_n, T_n and their ideals.

Alen Ðurić *(Institute of Mathematics, Physics and Mechanics (Slovenia))*

Wednesday 2 July, 12:12–12:21 • Room 110

Short Communications VII

Garside's coherent presentations of monoids

A monoid can be presented by generators and oriented relations (i.e. applicable only in one direction), called rewriting rules, between words (i.e. sequences of generators). A presentation of a monoid is called coherent if it is enhanced with relations among relations 'filling' any parallel pair of sequences of relations. Deligne constructed coherent presentations for spherical Artin-Tits monoids. Gaussent, Guiraud and Malbos extended this result in two distinct directions: to all Artin-Tits monoids and to Garside monoids. In this talk, we present a unifying generalisation of these two results in the setting of Garside families, a notion introduced in order to abstract the properties that yield the greedy normal form observed in braid monoids.

This is a joint work with Pierre-Louis Curien and Yves Guiraud, https://hal.science/hal-03276119v4/file/coherent.pdf.

Jozef Širáň *(Slovak University of Technology, Bratislava)*

Monday 30 June, 11:44–12:06 • Room 103

Thematic Session: Groups and Graphs

Orientably-regular embeddings of complete multigraphs

An embedding of a graph on an orientable surface is orientably-regular *(or* rotary*, in an equivalent terminology) if the group of orientation-preserving automorphisms of the embedding is transitive (and hence regular) on incident vertex-edge pairs of the graph.*

A classification of orientably-regular embeddings of complete graphs was obtained by L. D. James and G. A. Jones (1985), pointing out interesting connections to finite fields and Frobenius groups.

By a combination of methods from abstract and combinatorial group theory we extend the results of James and Jones to classification of orientably-regular embeddings of complete multigraphs with arbitrary edge-multiplicity.

Extension of results on orientably-regular embeddings of simple graphs to multigraphs *in general is motivated by the fact that the latter appear to be prevalent for bounded genus. For example, by computational results of M. Conder, among all orientably-regular maps on surfaces up to genus 300 only about 11 per cent are such that both the map and its dual have a simple underlying graph.*

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