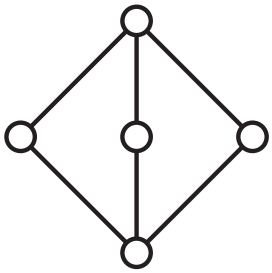

34th Victorian Algebra Conference

22 – 23 November 2016
La Trobe University

With financial support from the Australian Mathematical Society, via the *Victorian Algebra Group*, and La Trobe University's *Discipline Research Program in Mathematical and Computing Sciences*.

welcome

Welcome to the 34th Victorian Algebra Conference!

The main aim of the annual Victorian Algebra Conference is to foster communication between algebraists in Australia. We interpret algebra quite broadly, including areas such as topological algebra, algebraic logic, graph theory and coding theory.

The VAC has a proud tradition of encouraging talks by students: typically about one third of the talks are presented by students. The conference aims to provide graduate students in algebra with the opportunity to give their first public presentation in a relaxed and supportive environment. Each conference, the most outstanding student talk is awarded the Gordon Preston Prize.

The zeroth Victorian Algebra Conference, at La Trobe University in 1982, was actually a workshop on lattice theory and universal algebra, which was organised by Brian Davey because he had two international visitors, Heinrich Werner (Kassel) and Hilary Priestley (Oxford). This workshop brought together Australian algebraists from a wide range of areas, and its success led Gordon Preston to suggest "We should do this every year". The Algebra Conference of Victoria (ACV) and later the Victorian Algebra Conference (VAC) has been held every year since. This 34th iteration is of special significance, as it is the final conference to be held under the title *Victorian Algebra Conference*, with a change to the title *Australian Algebra Conference* expected to be approved for 2017.

information

talks

All talks will be held in Teaching Room 3 of the City Campus of La Trobe University: level 20 of 360 Collins Street, Melbourne CBD.

internet access

There is wireless internet throughout the campus, which you should be able to use if you have access to *eduroam*.

coffee/tea

Morning and afternoon tea will be served in the "Student Lounge" area to the left of Teaching Room 3 (as you leave it). There is a coffee machine with push-button operation. Please note that the Student Lounge is a shared area.

lunch

The majority of Melbourne CBD is within viable lunch-time walking distance. Some possible nearby areas to try out are as follows.

- **Degraves Street.** Head east across Elizabeth Street, then turn south down Centre Way (a little arcade/opening not far after Elizabeth Street is crossed). Alternatively, head left into Block Arcade until it becomes Block Place just before Bourke Street. Between Queen and Elizabeth Streets.
- **Hardware Lane precinct.** Directly north of the conference venue: just after Bourke Street is crossed.
- **Little Collins Street.** Even just around the back of 360 Collins Street you will find plenty of food (head a few metres east beyond the building, then take the first little laneway "Equitable Place").

coffee snobs

Nearby best speciality coffee shops (rankings from Beanhunter for greater Melbourne):

(#5) LB2, Speciality Coffee, 2 Gallagher Place. East of King St, on Ltl Collins St.
(#6) Patricia, 493–495 Ltl Bourke St. Just east of William St.
(#10) Cup of Truth, 12 Campbell Arcade, Degraves Street Subway. Hole-in-Wall.
(#13) Little Bean Blue, 15 Ltl Collins St. Just west of Spring St.
(#23) Brother Baba Budan, 359 Ltl Bourke St. Just west of Elizabeth St.

sponsors

This event is supported financially by the Victorian Algebra Group, itself supported as a special interest group of the Australian Mathematical Society. We thank the V.A.G. members for their support of the group, as financial assistance is granted on the basis of member numbers. In 2016, we have received invaluable extra support from La Trobe University's *Discipline Research Program in Mathematical and Computing Sciences*, which supports research-related activities in the area.

questions?

Feel free to ask us, or any of the other locals, if you need assistance during the conference.

Brian Davey and Marcel Jackson
Department of Mathematics and Statistics, La Trobe University

conference dinner

The conference dinner is on Tuesday, 6pm, at *+39 Pizzeria*, 362 Little Bourke Street, in the CBD.

We are having the $35 set menu ($20 for students), with

> Appetizer: La giardiniera (mixed Italian pickles)
> Antipasto: Our signature stendino served with focaccia semplice
> Mains: Selection of pizzas and pastas served with side salad

To get to the restaurant from the conference venue, walk west (slightly downhill) to Elizabeth Street, then take a left turn up this (northwards), past Bourke Street until you reach Little Bourke Street. Turn left into this, and it should appear on the right-hand side after only about 50 metres or so.

participants

current as of Sun 20 Nov 2016

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abstracts

1. Topological recursion: A glimpse via Bousquet-Mélou–Schaeffer numbers

Anupam Chaudhuri (Monash University)

15:00 Tue 22 November 2016

Bousquet-Mélou–Schaeffer (BMS) numbers count the number of ways a permutation can be written as product of a fixed number of permutations. We will show that BMS numbers also enumerate branched covers of the sphere and can be calculated using the representation theory of the symmetric group. We provide evidence towards the conjecture that BMS numbers are governed by the topological recursion. The topological recursion is a machinery that arises in mathematical physics but has found diverse applications to problems in combinatorics, knot theory, algebraic geometry, and more.

2. The homomorphism lattice induced by a finite algebra

Brian Davey (La Trobe University)
with Charles Gray and Jane Pitkethly

15:00 Wed 23 November 2016

Each finite algebra $\mathbf{A}$ induces a lattice $\mathcal{L}_{\mathbf{A}}$ via the quasi-order $\to$ on the finite members of the variety generated by $\mathbf{A}$, where $\mathbf{B} \to \mathbf{C}$ if there exists a homomorphism from $\mathbf{B}$ to $\mathbf{C}$.

We introduce the question: 'Which lattices arise as the homomorphism lattice $\mathcal{L}_{\mathbf{A}}$ induced by a finite algebra $\mathbf{A}$?'

Our main result is that each finite distributive lattice arises as $\mathcal{L}_{\mathbf{Q}}$, for some quasi-primal algebra $\mathbf{Q}$. We also obtain all finite partition lattices and the pentagon lattice $\mathbf{N}_5$.

3. Groups with self-centralising subgroups

Heiko Dietrich (Monash University)

12:00 Wed 23 November 2016

A subgroup U of a group G is self-centralising if the centraliser of U in G is contained in U; in other words: if g in G satisfies $ug = gu$ for all u in U, then g is an element of U. The existence of self-centralising subgroups sometimes has strong implications on the structure of the group, and it is an open question to classify groups which have "many" self-centralising subgroups. In this talk we consider a few approaches and results towards such classifications; this is joint work with / based on work of Costantino Delizia, Primož Moravec, and Chiara Nicotera.

4. Solving twisted equations

Murray Elder (The University of Newcastle)

10:00 Tue 22 November 2016

I will define the notion of a *twisted equation* in a free monoid with involution, and give an indication of how we can solve them using *compression*, as we did for equations in free groups. This is joint work with Laura Ciobanu and Volker Diekert.

5. Some geometric properties of Cayley graphs

Andrew Elvey Price (The University of Melbourne)

14:30 Tue 22 November 2016

Over the years, many geometric properties of Cayley graphs have been introduced in order to aid in understanding the Cayley graphs and their underlying groups. For each of these properties two questions are inevitably asked: Is it strictly stronger or weaker than any other well known properties? Does it depend on the generating set or only the underlying group? I will discuss a number of these properties and known relationships between them. Finally I will describe two different Cayley graphs for the same group, $F_2 \times F_2$, which exhibit very different geometries. One of these Cayley graphs satisfies the fairly restrictive property, FFTP, while the other fails the much weaker property, MAC. As a result, these two properties as well as many others will be shown to depend on the generating set.

6. The history of Tutte-Whitney polynomials

Graham Farr (Monash University)

11:00 Wed 23 November 2016

The Tutte-Whitney polynomial of a graph is a two-variable polynomial that contains a lot of interesting information about the graph. It includes, for example, the chromatic, flow and reliability polynomials of a graph, the Ising and Potts model partition functions of statistical mechanics, the weight enumerator of a linear code, and the Jones polynomial of an alternating link.

We describe the early history of Tutte-Whitney polynomials, especially the contributions of the early papers of Whitney and Tutte.

7. Rank of equations in free groups

Michal Ferov (The University of Newcastle)

11:30 Wed 23 November 2016

Given a system of equations, several questions naturally arise: how big is the space of solutions, what is the "biggest" solution, are distinct solutions related in some way, how many degrees of freedom does do we have in the process of producing a solution?

In my talk I will describe different notions of rank of a system of equations over free groups and show some basic observations how they relate to each other.

This is ongoing joint work with Murray Elder.

8. A comparison of three types of ring extensions

Barry Gardner (University of Tasmania)
with Elena Cojuhari

12:30 Wed 23 November 2016

Normalizing extensions (NE) of rings with identity are exemplified by group rings, polynomial rings and matrix rings. *Subnormalizing extensions* (SNE) satisfy a weaker defining condition. A D-*structure* associated with a ring A with identity and a monoid G is a family of self-mappings of A labelled by G satisfying a rather intricate but natural set of conditions. These can be used to construct generalized monoid rings, which we'll call D-*monoid rings*. These include skew monoid rings as a special case. All NEs are SNEs, but not conversely. When the adjoined generating elements of a NE or a SNE form a monoid we can compare the extension to a D-monoid ring. All D-monoid rings which are NEs are skew monoid rings. The relationship between SNEs and D-monoid rings is much more complicated. A D-monoid ring can be a SNE but be far from a skew monoid ring. Moreover, every SNE generated by a monoid is associated with a natural set of monoid-labelled self-maps of the initial ring

which is "almost" a D-structure, so such a SNE can be viewed as a generalized D-monoid ring (though not every D-monoid ring is a SNE). There are even monoids such that each SNE they generate defines a fair dinkum D-structure.

9. Mind the gap

Lucy Ham (La Trobe University)

12:00 Tue 22 November 2016

The constraint satisfaction problem (CSP) is the fundamental framework for a wide variety of computational problems in computer science and mathematics, including combinatorial problems such as graph colouring and other graph homomorphism problems.

The famous PCP Theorem of computational complexity shows that for NP-complete CSPs, it is NP-hard to distinguish those instances that are satisfiable from those that have at most $1 - \epsilon$ proportion of constraints satisfiable. We establish a new "gap" property of this style, showing that in many cases it is NP-hard to distinguish instances that are unsatisfiable from those that have an extremely flexible form of satisfaction: for any fixed $k \geq 0$, any assignment on k variables extends to a full satisfying assignment.

We establish a *Gap Trichotomy Theorem* for CSPs on 2-element domains, completely classifying the intractability of these gap properties. Many particular variants of the CSP are covered as special cases, including the *separation problem* (can distinct variables be validly assigned distinct values?) and Schaefer's original dichotomy for SAT variants. With more effort, we are also able to extend the gap property classification to *any* CSP where the famous "algebraic dichotomy conjecture" holds, including list homomorphism problems, homomorphism problems for simple graphs, and CSPs on small domains.

10. Weighted Leavitt path algebras

Roozbeh Hazrat (Western Sydney University)

16:30 Tue 22 November 2016

Weighted Leavitt path algebras are a generalisation of Leavitt path algebras (with graphs of weight 1) and cover the algebras $L_K(n, n+k)$ constructed by Leavitt. In this talk we explain the concept and prove some theorems on the structure of these algebras. This is a joint work with Raimund Preusser (Bielefeld).

11. Codes from groups and groups from codes

Kathy Horadam (Royal Melbourne Institute of Technology)

09:30 Wed 23 November 2016

For 20 years I have been interested in binary codes which can be derived from cocycles on groups. I will briefly describe the *coboundary codes* defined from any function $f : \mathbb{Z}_2^n \to \mathbb{Z}_2^n$ by $D_f = \{f(x) + f(y) + f(x+y),\ x, y \in \mathbb{Z}_2^n\}$ and give some results and open questions.

Just recently, I have come across a delightful 1989 construction due to Rifa, Basart and Huguet of a group structure on *propelinear* codes, that is, subsets C of $\mathbb{Z}_2^n$ containing the all-zero codeword such that for each codeword $x \in C$ there exists a coordinate permutation $\pi \in S_n$, with $\pi_0 = \mathrm{Id}$, satisfying the conditions: (i) For all $y \in C, x + \pi_x(y) \in C$, (ii) For all $x, y \in C, \pi_x \pi_y = \pi_z$, where $z = x + \pi_x(y)$.

This group in turn links to cocyclic Hadamard matrices (my first love) in a most intriguing way.

12. Angels and demons

Marcel Jackson (La Trobe University)
with Szabolcs Mikulas

15:30 Wed 23 November 2016

In the demonic composition of binary relations r and s, a point x is related to a point y if in addition to being related by the usual composition of r with s, we have that every point related to x by r lies in the domain of s.

When computer programs are modelled abstractly as binary relations on a state space, program composition corresponds to either the usual relational composition ("angelic composition") or to demonic composition, depending on how non-terminating computations are treated.

We give a complete equational axiomatisation for the abstract equational theory of binary relations with domain and range in the case of both angelic and demonic composition. Both have finite axiomatisations and turn out to be reasonably natural and known varieties.

13. Restricted Priestley duality for distributive lattices with order inverting operation

Tomasz Kowalski (La Trobe University)
with Eli Hazel

14:30 Wed 23 November 2016

We present a simple duality for distributive lattices with an order inverting operation. It naturally generalises similar dualities for well known cases where the additional operation was required to satisfy stronger conditions, for example, to be an involution. These particular cases are recovered by imposing reasonably natural conditions on the dual category.

14. The injective Leavitt complex

Huanhuan Li (Western Sydney University)

16:00 Tue 22 November 2016

For a finite quiver Q without sinks, we consider the corresponding finite dimensional algebra A with radical square zero. We construct an explicit compact generator for the homotopy category of acyclic complexes of injective A-modules. We call such a generator the injective Leavitt complex of Q. This terminology is justified by the following result: the differential graded endomorphism algebra of the injective Leavitt complex of Q is quasi-isomorphic to the Leavitt path algebra of Q. Here, the Leavitt path algebra is naturally Z-graded and viewed as a differential graded algebra with trivial differential.

15. Nilpotent associative algebras and coclass theory

Tobias Moede (Monash University)

17:00 Tue 22 November 2016

The coclass of a finite p-group of order p^n and class c is defined as $n - c$. In 1980 Leedham-Green & Newman suggested to use coclass as the primary invariant in a possible classification of finite p-groups. Coclass theory has proven to be a very fruitful approach in the investigation of finite p-groups.

We have developed a coclass theory for nilpotent associative algebras over fields. A central tool in our investigation are so-called coclass graphs associated with the nilpotent associative F-algebras of a fixed coclass. We prove several structural results for the associated coclass graphs. This yields results in the flavour of the coclass theorems for finite p-groups. Furthermore, we present some intriguing periodicity conjectures for coclass graphs.

This is joint work with Bettina Eick (TU Braunschweig, Germany)

16. Expansions of dually pseudocomplemented Heyting algebras

Christopher Taylor (La Trobe University)

11:30 Tue 22 November 2016

Fundamental to the theory of Heyting algebras is the fact that the lattice of congruences on a Heyting algebra is isomorphic to the lattice of filters of the underlying lattice. We investigate the consequences of including further operations in the signature. Filters are still involved, and this leads to natural interest in characterising the filters that correspond to congruences on the expanded algebra. We will call such a filter a *normal filter*.

We utilise a method of Hasimoto to produce, in certain cases, a unary term that determines normal filters, which we call a *normal filter term*. We extend his existence conditions to apply to a larger class of algebras, with particular emphasis on the dual pseudocomplement operation. The presence of a normal filter term and the dual pseudocomplement operation is powerful enough to yield rather strong results. In particular we characterise varieties with equationally definable principal congruences, and prove that a variety of these algebras is semisimple if and only if it is a discriminator variety.

17. The Thickness of Schubert Cells

Jon Xu (The University of Melbourne)

12:30 Tue 22 November 2016

In finite geometry, the important objects of study are those which conceptually satisfy two conditions: 'thinness' and 'maximality'. In geometric representation theory, a crucial object of study is the flag variety and its accompanying decomposition into Schubert cells.

In my talk, I will outline a combinatorial method of calculating the thickness of a Schubert cell by multiplying certain elements of the underlying Weyl group. I will demonstrate how this calculation uncovers many examples of thin sets of Schubert cells and is therefore a first step in bringing together the areas of finite geometry and geometric representation theory. This is joint work with Arun Ram (University of Melbourne) and John Bamberg (University of Western Australia).

timetable

Tuesday	
9:00--10:00	Registration and Coffee
10:00--11:00	**Murray Elder**
11:00--11:30	Morning Tea
11:30--12:00	**Chris Taylor**
12:00--12:30	**Lucy Ham**
12:30--1:00	**Jon Xu**
1:00--2:30	Lunch
2:30--3:00	**Andre Elvey-Price**
3:00--3:30	**Anupam Chaudhuri**
3:30--4:00	Afternoon Tea
4:00--4:30	**Huanhuan Li**
4:30--5:00	**Roozbeh Hazrat**
5:00--5:30	**Tobias Moede**
5:30--6:00	Walk to dinner
6:00--	Conference Dinner

Wednesday	
9:30--10:30	**Kathy Horadam**
10:30--11:00	Morning Tea
11:00--11:30	**Graham Farr**
11:30--12:00	**Michal Ferov**
12:00--12:30	**Heiko Deitrich**
12:30--1:00	**Barry Gardner**
1:00--2:30	Lunch and AGM
2:30--3:00	**Tomasz Kowalski**
3:00--3:30	**Brian Davey**
3:30--4:00	**Marcel Jackson**
4:00--4:30	Afternoon Tea