36ACCMCC

The 36th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing

10 - 14 December 2012, The University of New South Wales, Sydney, Australia

CMSA (Inc.)

Programme

UNSW AUSTRALIA

36ACCMCC Programme

Welcome function

There will be an informal welcome function from 17:00 – 19:00 on Sunday 9 December 2012, with registration available from 16:00. This will be held in the School of Mathematics and Statistics staff room, Level 3 of the Red Centre Building (East Wing), UNSW. The Red Centre Building is labeled H13 on the Kensington Campus map of UNSW that you can find here. Come along and enjoy some snacks, drinks and combinatorial company.

Programme

The conference will be held in the Old Main Building (OMB) of UNSW, building K15 on the campus map. Invited talks will take place in room OMB-149, and contributed talks in three parallel sessions, in rooms OMB-149, OMB-145, and OMB-144. Contributed talks are 25 minutes long, including time for questions. This allows 5 minutes between talks for delegates to move between sessions.

CMSA AGM

The annual general meeting of the Combinatorial Mathematical Society of Australasia (CMSA) will be held on Tuesday 11 December 2012 at 17:30 (directly after the last talk), in OMB-149. By registering for 36ACCMCC, you have probably become a member of the CMSA for the next 12 months (unless you answered “No” when offered this membership during the online registration process). All CMSA members are welcome at the AGM.

Conference excursion

There will be a conference excursion on the afternoon of Wednesday 12 December 2012. We will depart by coach from UNSW at 12:10. First we drive to Audley in the Royal National Park, south of Sydney, where a picnic lunch will be provided. Then you can enjoy the peaceful setting, or go on a short bush walk, or hire a boat or a bicycle for an hour from the historic Audley boat shed.

Next, we will visit the Symbio Wildlife Park to see koalas and other animals from Australia and overseas. After leaving Symbio, if the weather is fine, we may make a brief stop at a coastal lookout for a quick photo opportunity, before driving back to UNSW.

Conference dinner

The conference dinner will be held on Thursday 13th December 2012, at the Crowne Plaza Hotel, Coogee Beach (see map on rear cover), starting with welcome drinks at 18:30. The Crowne Plaza is on the corner of Arden Street and Carr Street, Coogee (enter from Carr Street). This is about 3km from UNSW: either a short bus ride or a 40 minute walk.

36ACCMCC organisers

Julian Abel
Thomas Britz
Diana Combe
Catherine Greenhill
Kaye Sedgers

Monday

	OMB-149	**OMB-145**	**OMB-144**
09:00	**Ron Aharoni** *Beyond Hall's Theorem – independent systems of representatives* (p1) Chair: Wanless		
10:00	Alexander Muir *Characterising infinite 1-searchable graphs* (p37) Chair: MacGillivray	Sarada Herke *The application of donut graphs to the P1F problem for circulants* (p20) Chair: Wanless	Keisuke Shiromoto *Codes over rings and matroids* (p44) Chair: Britz
10:30	Morning Tea		
11:00	Michael Albert *New techniques in permutation class enumeration* (p6) Chair: McKay	R. Feria Puron *Recent advances in the Degree/Diameter Problem for bipartite graphs* (p16) Chair: Little	Irene Pivotto *Maximum sized binary matroids with no $AG(3,2)$ minor* (p41) Chair: Britz
11:30	Mikhail Isaev *Asymptotic enumeration of Eulerian circuits and orientations for graphs with strong mixing properties* (p23) Chair: McKay	Guillermo Pineda-Villavicencio *On the degree/diameter problem for minor-closed graph classes* (p41) Chair: Little	Amanda Cameron *Kinser inequalities and related matroids* (p9) Chair: Britz
12:00	Zuhe Zhang *The enumeration of independent sets on some lattices* (p50) Chair: McKay	Mirka Miller *Moore graphs and beyond: recent advances in the degree/diameter problem* (p35) Chair: Little	Nick Brettell *Constructing a k-tree for a k-connected matroid* (p9) Chair: Britz
12:30	Lunch		
14:00	**Daniel Horsley** *Embeddings of partial Steiner triple systems: best-possible and better* (p2) Chair: Billington		
15:00	Hyunwoo Jung *Lattice path counting without touching a line with no consecutive horizontal segments* (p25) Chair: Osborn	William Pettersson *Finding manifolds by cycle decompositions* (p40) Chair: Billington	Vladimir Ejov *"Snakes and Ladders" heuristic algorithm for the Hamiltonian Cycle Problem* (p13) Chair: Greenhill
15:30	Afternoon Tea		
16:00	James Zhao *A hybrid algorithm for sampling graphs with given degree sequence* (p51) Chair: Brankovic	Nicholas J. Cavenagh *I'm plexy and I know it* (p10) Chair: Barat	Murray Smith *Generalising the clique-coclique bound* (p45) Chair: Gillespie
16:30	Kosuke Koba *Hitting time and cover time on dynamic graphs* (p27) Chair: Brankovic	Ian Wanless *The order of quasigroup automorphisms* (p49) Chair: Barat	Xiaogang Liu *Spectral properties of unitary Cayley graphs of finite commutative rings* (p31) Chair: Gillespie
17:00	Yusuke Hosaka *Fast random walk and its stationary distribution* (p22) Chair: Brankovic		Brian P. Corr *Extending Quokka Theory to singular matrices* (p11) Chair: Gillespie

Tuesday

	OMB-149	OMB-145	OMB-144
09:00	**Carsten Thomassen** *The Weak Circular Flow Conjecture and applications* (p4) Chair: Farr		
10:00	Glenn Hurlbert *Graph pebbling: new results and open problems* (p23) Chair: Farr	Sylvia Morris *Small order spreads of $W(5, q)$* (p37) Chair: Wong	Daniel R. Hawtin *Elusive codes in Hamming graphs* (p20) Chair: Britz
10:30	Morning Tea		
11:00	Vaipuna Raass *Full critical sets of full latin squares* (p42) Chair: Horsley	Yee Ka Tai *Non-classical polar unitals in finite Dickson semifield planes* (p47) Chair: Leemans	Neil Gillespie *Completely regular codes with large minimum distance* (p18) Chair: Britz
11:30	Jayama Mahamendige *Cycle structure of autoparatopisms of quasigroups and Latin squares* (p32) Chair: Horsley	Philip P.W. Wong *The geometry of inversive planes and the automorphism group of the Dickson-Ganley unitals* (p49) Chair: Leemans	Maheswara Rao Valluri *Public key authentication schemes using polynomials over non-commutative groups* (p48) Chair: Britz
12:00	Tony Grubman *Embedding spherical latin trades into abelian groups* (p19) Chair: Horsley	Alice M. W. Hui *On embedding a unitary block design as a polar unital and a new intrinsic characterization of the classical unital* (p22) Chair: Leemans	Tatsuya Maruta *Geometric puncturing for linear codes over finite fields* (p33) Chair: Britz
12:30	Lunch		
14:00	**Christine M. O'Keefe** *Confidentiality, privacy and combinatorics* (p2) Chair: Rodger		
15:00	Gordon Royle *The Merino-Welsh Conjecture for series-parallel graphs* (p43) Chair: Greenhill	Thomas Connor *A rank 3 geometry for the O'Nan group related to the Livingstone graph* (p10) Chair: Wong	Randell Heyman *Counting polynomials that satisfy the Eisenstein criterion* (p21) Chair: Morgan
15:30	Afternoon Tea		
16:00	Chihiro Suetake *Class regular symmetric transversal designs with point semiregular automorphism groups* (p46) Chair: Abel	Graham Farr *Trinity and minors for alternating dimaps* (p15) Chair: Ellingham	Natalya Levenkova *A time-evolving random network based on random geometric graphs and random motion* (p29) Chair: Morgan
16:30	Kazuhiko Ushio *Balanced (C_9, C_{14})-foil designs and related designs* (p48) Chair: Abel	Bin Jia *Hadwiger's Conjecture for ℓ-link graphs* (p24) Chair: Ellingham	Douglas S. Stones *The trouble with network motifs: an analytical perspective.* (p46) Chair: Morgan
17:00	Fatih Demirkale *Intersection problem for simple 2-fold $(3n, n, 3)$ group divisible designs* (p12) Chair: Abel	Sarfraz Ahmad *On barycentric subdivision of a simplicial complex* (p6) Chair: Ellingham	Marsha Minchenko *Investigating the missing Moore graph* (p36) Chair: Morgan
17:30	CMSA AGM		

Wednesday

	OMB-149	OMB-145	OMB-144
09:00	**Chris Rodger** *Enclosing and existence of cycle systems* (p3) Chair: Aharoni		
10:00	Daniel Harvey *Treewidth of line graphs* (p19) Chair: Lau	Serge Gaspers *Extremal vertex sets and their numbers* (p18) Chair: Hurlbert	Hamid Mokhtar *An approximation algorithm for routing and wavelength assignment on WDM 4-regular circulant networks* (p36) Chair: Greenhill
10:30	Morning Tea		
11:00	Mohammadreza Jooyandeh *Planar hypohamiltonian graphs on 40 vertices* (p25) Chair: Lau	Jessica McClintock *Extremal graph theory for book embeddings* (p34) Chair: Hurlbert	Ljiljana Brankovic *Parameterised approximation: combining two worlds* (p8) Chair: Yeo
11:30	Hooman Reisi Dehkordi *A conjecture on right-angle crossing drawing of 1-plane graphs* (p11) Chair: Lau	Michael S. Payne *On the general position subset selection problem* (p39) Chair: Hurlbert	Yaya S. Kusumah *Insertion-triangulation techniques for solving the facility layout design problems* (p27) Chair: Yeo
12:00	Excursion		

Thursday

	OMB-149	OMB-145	OMB-144
09:00	**Frank Ruskey** *The mysterious nature of nested recurrence relations* (p3) Chair: McKay		
10:00	Florian Lehner *Distinguishing graphs with intermediate growth* (p29) Chair: Bryant	David R. Wood *Nonrepetitive colouring via entropy compression* (p50) Chair: Greenhill	Hideaki Suto *Independent spanning trees of Cayley graph of transposition tree* (p47) Chair: Pineda-Villavicencio
10:30	Morning Tea		
11:00	Saad I. El-Zanati *On decomposing regular graphs and multigraphs into isomorphic trees* (p14) Chair: Bryant	Brendan McKay *Some divers observations on switching reconstruction (part 1)* (p34) Chair: Royle	Oudone Phanalasy *An application of completely separating systems to graph labeling* (p40) Chair: Pineda-Villavicencio
11:30	Elizabeth J. Billington *Graph metamorphosis: theta graphs to cycles* (p7) Chair: Bryant	Beáta Faller *Some divers observations on switching reconstruction (part 2)* (p15) Chair: Royle	Michael Reynolds *Alpha-labellings of trees with maximum degree* 3 *and a perfect matching* (p42) Chair: Pineda-Villavicencio
12:00	David Fear *Cyclotomic orthomorphisms* (p16) Chair: Bryant	Jeanette McLeod *Some divers observations on switching reconstruction (part 3)* (p35) Chair: Royle	Gee-Choon Lau *On k-hamiltonicity of bipartite and tripartite graphs* (p28) Chair: Pineda-Villavicencio
12:30	Lunch		
14:00	**Marston Conder** *Graph symmetries* (p1) Chair: Royle		
15:00	Charles Little *Matching covered graphs with three removable classes* (p30) Chair: Osborn	Janos Barat *Ryser's conjecture for intersecting hypergraphs* (p7) Chair: Wood	Arun P. Mani *R-submodularity and negative correlation in graphs* (p32) Chair: Cavenagh
15:30	Afternoon Tea		
16:00	Brian Alspach *The Coxeter group project: a progress report* (p6) Chair: Conder	Fabrizio Frati *A planar graph decomposition with applications to graph layout* (p17) Chair: Wood	Yutaka Hiramine *On an extension of difference matrices* (p21) Chair: Cavenagh
16:30	Dimitri Leemans *Suzuki groups are more chiral than regular* (p28) Chair: Conder	Mark Ellingham *Closed 2-cell embeddings under partial duality* (p14) Chair: Wood	Padraig Ó Catháin *Inequivalence of difference sets* (p38) Chair: Cavenagh
17:00	Alice Devillers *Local 2-geodesic transitivity of graphs* (p12) Chair: Conder	Peter Eades *Some remarks on the weighted barycentre algorithm* (p13) Chair: Wood	Bernhard Schmidt *Multipliers of difference sets* (p44) Chair: Cavenagh
18:30	Conference Dinner		

Friday

	OMB-149	OMB-145	OMB-144
09:00	**Anders Yeo** *Fixed-parameter tractability above lower bounds* (p4) Chair: Greenhill		
10:00	Jamie Simpson *The total run length of a word* (p45) Chair: Wanless	Yuqing Lin *Forcing number and anti-forcing number of fullerenes* (p30) Chair: Osborn	Joe Ryan *Degree Diameter Maximum Subgraph Problem* (p43) Chair: Britz
10:30	Morning Tea		
11:00	Gary MacGillivray *Homomorphically full reflexive graphs and digraphs* (p31) Chair: Simpson	Nicholas Mattei *Bribery and manipulation in tournaments with uncertain information* (p33) Chair: Gaspers	Elgin Kiliç *Accessibility number and total accessibility* (p26) Chair: Greenhill
11:30	Judy-anne Osborn *Bounds on minors of binary matrices* (p39) Chair: Simpson	Nina Narodytska *Coalitional manipulation for Schulze's Rule* (p38) Chair: Gaspers	
12:00	Richard P. Brent *Lower bounds on maximal determinants via the probabilistic method* (p8) Chair: Simpson	Haris Aziz *A graph-theoretic view of a fundamental model of exchange economy* (p7) Chair: Gaspers	

Abstracts of invited talks

Beyond Hall's Theorem – independent systems of representatives

Ron Aharoni

Technion

Hall's Theorem provides a necessary and sufficient condition for the existence of an injective choice function for a given collection of sets V_i. In a more general setting, some structure is given on $\bigcup V_i$ and the requirement is added that the range of the choice function belongs to this structure. For example, that the range is independent in some given matroid (this is the setting of Rado's Theorem) or independent in some given graph on $\bigcup V_i$. The elements chosen are called then an "independent system of representatives" (ISR). Many problems can be formulated in this setting - for example coloring of graphs, or list coloring. ISR problems are typically NP-hard, so no necessary and sufficient condition is expected to be found for their existence, but some tools - topological and algebraic - have been developed that provide sufficient conditions. The talk is a survey of these methods, and of applications of ISR's.
(Monday 09:00)

Graph symmetries

Marston Conder

University of Auckland

This will be a wide-ranging survey of a number of things about symmetries of graphs, including types of symmetry and associated properties, both global and local, similar issues for graph embeddings, theorems on maximum symmetry, constructions for graphs and maps with a high degree of symmetry subject to various constraints, and so on. These will be accompanied by lots of examples and illustrations. I will also mention some recent developments and open problems.
(Thursday 14:00)

Embeddings of partial Steiner triple systems: best-possible and better

Daniel Horsley

Monash University

A Steiner triple system $(V, \mathcal{B})$ of order v is a set V of v points together with a collection $\mathcal{B}$ of triples of those points such that each pair of points appears in exactly one triple. It is known that these exist if and only if $v \equiv 1, 3 \pmod 6$. If instead each pair of points appears in at most one triple we have a partial Steiner triple system of order v. A partial Steiner triple system $(U, \mathcal{A})$ has an embedding of order v if there is a Steiner triple system $(V, \mathcal{B})$ of order v such that $U \subseteq V$ and $\mathcal{A} \subseteq \mathcal{B}$.

In 1978 Lindner conjectured that every partial Steiner triple system of order u has an embedding of order v for each $v \geqslant 2u + 1$ such that $v \equiv 1, 3 \pmod 6$. After many partial results, a complete proof of this conjecture was obtained in 2009. This result is best-possible in the sense that for each $u \geqslant 9$ there is a partial Steiner triple system of order u that does not have an embedding of order smaller than $2u + 1$. Of course, many partial Steiner triple systems do have embeddings of order smaller than $2u + 1$. Much less is known about these embeddings, and there is a wide range of interesting questions concerning them.

In this talk I will give an overview of the problem of embedding partial Steiner triple systems and discuss some recent results on embeddings of order smaller than $2u + 1$.
(Monday 14:00)

Confidentiality, privacy and combinatorics

Christine M. O'Keefe

CSIRO

Vast amounts of data are now being generated from scientific research, observational projects, instruments and sensors of many kinds. The need to protect the privacy of individuals in the context of health databases is well-recognised, however confidentiality can also be an issue with business datasets, which often contain commercially sensitive information.

In this talk I will give an introduction to the area of confidentiality protection, including discussing a range of traditional and emerging approaches to disclosure control. I will focus in particular on the use of combinatorial concepts and techniques.
(Tuesday 14:00)

Enclosing and existence of cycle systems

Chris Rodger

Auburn University

An m-cycle system of G is a partition of the edges of G, each element of which induces an m-cycle. We consider two scenarios.

If G happens to be λK_v then this system said to be an m-cycle system of order v and index λ. The enclosing problem is to decide when there exists an m-cycle system of order $v+u$ and index $\lambda+\mu$ that contains an m-cycle system of order v and index λ in the case where $u > 0$ and $\mu > 0$. As one might expect, the problem is more difficult when m is odd and when u is small. Work towards solving this problem when $m \leqslant 5$ will be discussed. (If $\mu = 0$ then this would be called an embedding.)

If G can be formed from vertex disjoint copies of $\lambda_1 K_n$ by joining each vertex in each copy to each vertex in each other copy with λ_2 edges then the system is said to be an m-cycle system with two associate classes. So the existence problem for these graphs involves 4 parameters! It has been solved when m is 3, 4 or $|V(G)|$. Other results concern cycle systems of this graph that are required to have extra properties such as being resolvable or gregarious (that is, the vertices in each cycle are required to be spread out as evenly as possible among the copies of $\lambda_1 K_n$). As time permits, some or all of these results will be discussed.
(Wednesday 09:00)

The mysterious nature of nested recurrence relations

Frank Ruskey

University of Victoria, Canada

In the 1979 Pulitzer Prize winning book “Gödel, Escher, Bach: an Eternal Golden Braid”, Douglas R. Hofstadter introduced the recurrence relation

$$Q(n) = Q(n - Q(n-1)) + Q(n - Q(n-2))$$

with $Q(1) = Q(2) = 1$. We call this a nested recurrence relation because it has a sub-expression of the form $\ldots Q(\ldots Q(\ldots)\ldots)\ldots$. Other than composition, the only operations that are used are addition and subtraction.

Some nested recurrence relations have a solution and combinatorial interpretations, while others seemingly do not. For example it is still unknown whether $Q(n)$ is defined for all n. On the other hand, for the closely related recurrence

$$T(n) = T(n-1-T(n-1)) + T(n-2-T(n-2))$$

with $T(1) = T(2) = 1$, the number $T(n)$ counts the maximum number of leaves at the lowest level in a binary tree with n nodes. Some nested recurrence relations are undecidable in the sense that there is no algorithm to decide whether, given a set of initial conditions, they are well-defined for all $n > 0$. The purpose of this talk is to introduce nested recurrence relations, discuss some of the known results, and present tantalizing open problems.

This is joint work with Marcel Celaya, Steve Tanny, Brad Jackson, Alejandro Erickson and Bram Isgur.
(Thursday 09:00)

The Weak Circular Flow Conjecture and applications

Carsten Thomassen

Danish Technical University

Tutte's 3-Flow Conjecture says that every 4-edge-connected graph has an orientation such that, for each vertex x, the indegree of x equals the outdegree of x modulo 3. In 1988 Jaeger suggested a weaker conjecture obtained by replacing 4 by a larger (universal) number and called that **the Weak 3-Flow Conjecture**. He also suggested a stronger conjecture, called **the Circular Flow Conjecture**.

In this talk we indicate a proof of the Weak Circular Flow Conjecture (and hence also the Weak 3-Flow Conjecture) and discuss its applications to graph decomposition, group flow, and factors modulo k.
(Tuesday 09:00)

Fixed-parameter tractability above lower bounds

Anders Yeo

University of Johannesburg

A problem is fixed-parameter tractable (FPT) if given a parameter k (often, but not always, related to the solution size) there is an algorithm of complexity $O(f(k)n^c)$ for instances of size n, where $f(k)$ is a function and c is a constant. Therefore, if k is considered a constant then the problem is polynomial and the exponent does not depend on k. For FPT to be a useful tool we want the parameter, k, to be small. Therefore if there is a (tight) lower bound on the solution size, then a recent approach is to parameterize above this lower bound. For example it is known that one can always satisfy 7/8'th of all clauses in 3-SAT. So one question could be if we can satisfy k clauses more than this.

In this talk we will give an introduction to FPT, using a problem from the area of Information Security as an example. This is followed by a discussion of the following two problems.

Satisfying Linear Equations Over $\mathbb{F}_2$: We are given variables $x_1, \ldots, x_n$ and m equations of the form $\sum_{i \in I} x_i = b$ (modulo 2), where $x_i, b \in \{0, 1\}$ and $I \subseteq \{1, 2, \ldots, n\}$ and each equation has a positive integral weight. Deciding the maximum weight of equations that can be simultaneously satisfied is NP-hard.

Let W be the sum of all weights. As $W/2$ is the average weight of a random solution, there always exists a solution of weight $W/2$. We outline how to show that it is FPT to decide if there is a solution of weight $W/2 + k$, where k is the parameter.

Max-r-SAT: We are given a formula in conjunctive normal form (CNF) with m clauses, such that each clause contains r variables. We want to decide what is the maximum number of clauses we can simultaneously satisfy. As $(1-2^{-r})m$ is a lower bound on the number of clauses that can be satisfied we will consider the problem of deciding if we can satisfy $(1-2^{-r})m+k$ clauses.

We will outline how to use the obtained result on satisfying linear equations over $\mathbb{F}_2$ (using pseudo-boolean functions as a stepping stone) in order to get FPT results for Max-r-SAT.

(Friday 09:00)

Abstracts of contributed talks

On barycentric subdivision of a simplicial complex

Sarfraz Ahmad* and Volkmar Welker

COMSATS Institute of Information Technology, Lahore-Pakistan.

The l^{th} partial barycentric subdivision is defined for a $(d-1)$-dimensional simplicial complex Δ and studied along with its combinatorial, geometric and algebraic aspects. We analyze the behavior of the f- and h-vector under the l^{th} partial barycentric subdivision extending previous work of Brenti and Welker on the standard barycentric subdivision – the case $l = 1$. We discuss and provide properties of the transformation matrices sending the f- and h-vector of Δ to the f- and h-vector of its l^{th} partial barycentric subdivision. We conclude with open problems. (Tuesday 17:00)

New techniques in permutation class enumeration

Michael Albert

University of Otago

Permutation classes are collections of permutations closed under a natural substructure relationship. Recent theoretical advances have demonstrated that many such classes can be shown to have algebraic or rational generating functions based only on some relatively general characteristics. In this talk I will introduce these results and illustrate their application to some specific enumerative problems. (Monday 11:00)

The Coxeter group project: a progress report

Brian Alspach

University of Newcastle

I have started looking at Hamilton paths in certain Cayley graphs on Coxeter groups. This talk outlines some history, objectives and what I have been able to accomplish so far.
(Thursday 16:00)

A graph-theoretic view of a fundamental model of exchange economy

Haris Aziz* and Bart de Keijzer

NICTA

The (Shapley-Scarf) housing market is a well-studied and fundamental model of an exchange economy. It can be modeled by a digraph in which agent points to his maximally preferred house and each house points to this owner. We discuss how fundamental graph-theoretic concepts such as absorbing sets, cycles, and perfect matchings, can be used to formulate algorithms for housing markets which satisfy various desirable game-theoretic properties.
(Friday 12:00)

Ryser's conjecture for intersecting hypergraphs

Janos Barat*, Ron Aharoni and Ian M. Wanless

Monash University

Ryser's conjecture is a scaled inequality between the cover number τ and the matching number of a hypergraph. For intersecting r-partite hypergraphs the conjecture is that $\tau \leqslant r-1$. This is open for $r \geqslant 6$. The conjecture is tight for infinitely many values of r as shown by the truncated projective plane. Mansour, Song and Yuster asked how many edges are necessary in such a hypergraph with $\tau \geqslant r-1$? We relate this question to a more general problem of Erdős and Lovász. We discuss some methods and examples showing the flavours of these type of questions.
(Thursday 15:00)

Graph metamorphosis: theta graphs to cycles

Elizabeth J. Billington*, Abdollah Khodkar, Dylan Petrusma and Matthew Sutton

The University of Queensland

A theta graph $\Theta(1,k,k)$ consists of three edge-disjoint paths of lengths $1,k,k$ having common end points. Equivalently, the graph $\Theta(1,k,k)$ is a cycle of length $2k$ with a single extra "diagonal" edge joining two vertices k apart in the $2k$-cycle.

Some results on a *metamorphosis* from a $\Theta(1,k,k)$ decomposition of K_n into a $2k$-cycle decomposition of K_n are given. We also fully solve the problem (and the case for all λ-fold decompositions) when $k=3$; the case $k=2$ was dealt with in 2005 by Lindner and Tripodi.
(Thursday 11:30)

Parameterised approximation: combining two worlds

Ljiljana Brankovic* and Henning Fernau

The University of Newcastle

Parameterised approximation is a relatively new but growing field of interest. It merges two ways of dealing with NP-hard optimisation problems, namely polynomial approximation and exact parameterised (exponential-time) algorithms. In this talk we illustrate parameterised approximation on (1) Vertex Cover, and (2) 3-Hitting Set.

1. We explore opportunities for parameterising constant factor approximation algorithms for Vertex Cover, and we provide a simple algorithm that works on any approximation ratio of the form $\frac{2l+1}{l+1}$, $l = 1, 2, \ldots$, and has complexity that outperforms previously published algorithms by Bourgeois et al. based on sophisticated exact parameterised algorithms. In particular, for $l = 1$ (factor-1.5 approximation) our algorithm runs in time $O^*(1.0883^k)$, where parameter $k \leqslant \frac{2}{3}\tau$, and τ is the size of a minimum vertex cover.

   Additionally, we present an improved polynomial-time approximation algorithm for graphs of average degree at most nine and a limited number of vertices with degree less than two.

2. We design and analyze simple search tree algorithms for approximating d-Hitting Set, focussing on the case of factor-2 approximations for $d = 3$. Our best algorithm runs in time $O * (1.2852^K)$. We also derive several results for hypergraph instances of bounded degree, including a new polynomial-time approximation algorithm.

(Wednesday 11:00)

Lower bounds on maximal determinants via the probabilistic method

Richard P. Brent*, Judy-anne H. Osborn and Warren D. Smith

Australian National University

The Hadamard maximal determinant problem is to find the maximal determinant $D(n)$ of a square $\{\pm 1\}$ matrix of given order n. Hadamard proved the upper bound $D(n) \leqslant n^{n/2}$, which is attained iff a Hadamard matrix of order n exists. This talk is concerned with lower bounds on $D(n)$ or on the normalised function $\mathcal{D}(n) := D(n)/n^{n/2}$.

Let $n = h + d$, where $h \leqslant n$ is the order of a Hadamard matrix and h is maximal for the given choice of n. We show that $\mathcal{D}(n) \geqslant \kappa_d > 0$, where κ_d depends on d but not on n. Lower bounds in the literature depend on both d and n, so our bounds are improvements for sufficiently large n. If the Hadamard conjecture is true, then $d \leqslant 3$ and $\kappa_d > 1/9$.

Using the probabilistic method pioneered by Erdős, without assuming the Hadamard conjecture, we can give various lower bounds on $\mathcal{D}(n)$. For example, if $h \geqslant 12d^3$ then $\mathcal{D}(n) \geqslant 0.5(0.342)^d$. The special case $d = 1$ was (essentially) already considered by Brown and Spencer, Erdős and Spencer, and (independently) Best, but the results for $d > 1$ appear to be new.

This talk will outline the main results and methods used to obtain them. For further details, see our preprint arXiv:1211.3248.

This is joint work with Warren D. Smith and Judy-anne Osborn. (Friday 12:00)

Constructing a k-tree for a k-connected matroid

Nick Brettell* and Charles Semple

University of Canterbury

Oxley, Semple and Whittle (2004) showed there is a tree that displays, up to a natural equivalence, all non-trivial 3-separations of a 3-connected matroid. Furthermore, Oxley and Semple (2012) showed that such a tree can be constructed in polynomial time. More generally, Clark and Whittle (2012) showed that for a tangle of order k in a graph or matroid that satisfies a necessary "robustness" condition, there is a tree that displays, up to a natural equivalence, all k-separations that are non-trivial with respect to the tangle. In particular, for a k-connected matroid there is a tree that displays all non-trivial k-separations. In this talk we discuss the construction of such a tree in polynomial time, for arbitrary k.
(Monday 12:00)

Kinser inequalities and related matroids

Amanda Cameron* and Dillon Mayhew

Victoria University of Wellington

Kinser (2011) developed a hierarchy of inequalities dealing with the dimensions of certain spaces constructed from a given quantity of subspaces. These inequalities can be applied to the rank function of a matroid, a geometric object concerned with dependencies of subsets of a ground set. A matroid satisfies the first of the Kinser inequalities if it is representable by a matrix with entries from some finite field. I will discuss further the matroids which satisfy each inequality and the structure of the hierarchy of such matroids. (Monday 11:30)

I'm plexy and I know it

Nicholas Cavenagh*, Jaromy Kuhl and Ian Wanless

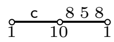
University of Waikato

(Subtitle: Longest partial transversals in plexes.) A *k-protoplex* of order n is a partial Latin square such that each row and column contains precisely k symbols, and each symbol occurs exactly k-times. A protoplex is a *plex* if the partial Latin square has a completion to a Latin square of the same order. A *partial transversal* is a partial Latin square such that each row, column and symbol occurs at most once. In this talk we consider the problem of finding the largest possible partial transversal in an arbitrary protoplex. A result by Aharoni on hypergraphs implies that any protoplex of order n has a partial transversal of size at least $n/2$. We show that a longer partial transversal may be found whenever $k \geqslant 3$. Since a Latin square is precisely an n-plex of order n, this is a generalization of the well-studied problem of finding the longest partial transversal within an arbitrary Latin square, conjectured to be of length n when n is odd (Ryser) and $n-1$ when n is even (Brualdi). (Monday 16:00)

A rank 3 geometry for the O'Nan group related to the Livingstone graph

Thomas Connor

Free University of Brussels

We construct a rank 3 geometry $\Gamma(O'N)$ over the diagram 

whose automorphism group is the O'Nan sporadic simple group. The maximal parabolic subgroups are the Janko group J_1, $2 \times S_5$ and the Mathieu group M_{11}. Our construction is based on a convenient amalgam of known geometries of rank 2 for J_1 and M_{11} extracted from the subgroup lattice of $O'N$. (Tuesday 15:00)

Extending Quokka Theory to singular matrices

Brian P. Corr* and Cheryl E. Praeger

University of Western Australia

The Quokka Theory of Niemeyer and Praeger provides a robust and widely applicable framework for determining the size of certain subsets of $GL(n, q)$. A subset $Q \subseteq G = GL(n, q)$ is said to have the *Quokka Property* if it is a union of conjugacy classes of G, and if membership of g in Q depends only on the semisimple part s in the multiplicative Jordan decomposition of g. Quokka Theory provides an effective way of finding exactly the proportion $|Q|/|G|$, reducing the problem to two parts: counting in a permutation group, and counting in an Abelian group.

It is often possible to use the Quokka theory to study non-Quokka sets, by finding a subset with the Quokka property and thus finding a lower bound on the proportion. However, sets of matrices which include singular matrices cannot be studied with the Quokka theory, as it depends on the multiplicative Jordan decomposition, which in turn requires that the matrices be invertible. In this work we use combinatorial methods to circumvent this limitation, and extend the Quokka theory to sets of matrices which may or may not be invertible.
(Monday 17:00)

A conjecture on right-angle crossing drawing of 1-plane graphs

Hooman Reisi Dehkordi*, Peter Eades and SeokHee Hong

University of Sydney

There is strong empirical evidence that human understanding of a graph drawing is negatively correlated with the number of edge crossings. However, recent experiments show that one can reduce the negative effect by ensuring that the edges that cross do so at large angles. These experiments have motivated a number of mathematical and algorithmic studies of "Right Angle Crossing (RAC)" drawings of graphs, where the edges cross each other perpendicularly.

In this talk, we focus on the straight-line RAC drawing of a class of graphs called "1-plane graphs" where each edge is crossed at most once. It is shown that 1-plane graphs have straight-line drawings if and only if they do not contain two forbidden patterns. We add four more forbidden patterns to this list and conjecture that 1-plane graphs which contain none of these six patterns admit a straight-line RAC drawing. We provide some evidence suggesting the correctness of the conjecture. Finally, we relate our conjecture to the Brightwell-Scheinerman "primal-dual circle packing" theorem, showing that it is in a sense a generalization of this theorem. (Wednesday 11:30)

Intersection problem for simple 2-fold $(3n, n, 3)$ group divisible designs

Fatih Demirkale*, Diane Donovan and C. C. Lindner

University of Queensland

In this talk, we will address the problem of intersection numbers for simple 2-fold $(3n, n, 3)$ group divisible designs (GDD). More precisely, we will present constructions which show that there exists two simple 2-fold $(3n, n, 3)$ GDDs which intersect in precisely $k \in \{0, 1, 2, \ldots, 2n^2\} \setminus \{2n^2-1, 2n^2-2, 2n^2-3, 2n^2-5\}$ triples for $n \geqslant 5$. There are some exceptions for $n = 3, 4$. (Tuesday 17:00)

Local 2-geodesic transitivity of graphs

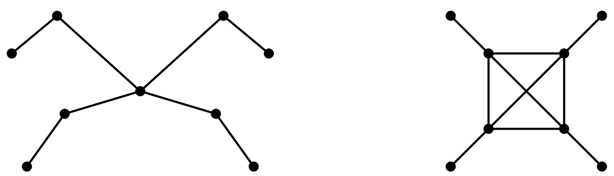
Alice Devillers*, Wei Jin, Cai Heng Li and Ákos Seress

The University of Western Australia

An s-geodesic in a graph is a shortest path connecting two vertices at distance s. We say that a graph is locally transitive on s-geodsics if the stabiliser of any vertex is transitive on the s-geodesics starting at that vertex. Being locally transitive on s-geodesic is not a monotone property: if an automorphism group G of a graph Γ is locally transitive on s-geodesics, it does not follow that G is locally transitive on shorter geodesics.

This situation is in stark contrast with the properties of s-arc transitivity. A graph Γ is called *locally* (G, s)*-arc transitive* if the stabiliser of any vertex v in G is transitive on the s-arcs starting at v. It can easily be proved that a locally s-arc transitive graph is also locally t-arc transitive for all $t < s$ if and only if every vertex has valency at least two, or $s = 2$ and the graph is a star.

In this talk, I will show a nice characterisation of all graphs that are locally transitive on 2-geodesics, but not locally transitive on 1-geodesics. Below are two examples of such graphs.



(Thursday 17:00)

Some remarks on the weighted barycentre algorithm

Peter Eades

University of Sydney

Tutte's celebrated barycentre algorithm takes a triconnected planar graph G as input and constructs a planar drawing of G with straight-line edges and convex faces. The algorithm is simple: it first draws a given face as a convex polygon, then places each other vertex at the barycentre of its neighbours.

It is well known that the algorithm works just as well when the edges are weighted, and vertices are placed at the weighted barycentre. In this talk we show how the weighted version of the barycentre algorithm can be used to give a number of different kinds of graph drawing. These include constraints on vertex positions and "morphing" between a number of drawings of a graph.

We illustrate the methods with drawings and animations of graphs. (Thursday 17:00)

"Snakes and Ladders" heuristic algorithm for the Hamiltonian Cycle Problem

P. Baniasadi, V. Ejov*, J.A. Filar, M. Haythorpe, and S. Rossomakhine

Flinders University

We present a polynomial complexity heuristic for solving the Hamiltonian Cycle Problem in an undirected graph of order n. Although finding a Hamiltonian cycle is not theoretically guaranteed, we have observed that the heuristic is successful even in cases where such cycles are extremely rare, and it also performs very quickly on all HCP examples of large graphs listed on TSPLIB web page. To date, we have not found a graph of the size $n \leqslant 3000$ for which the algorithm does not work. The heuristic owes its name to a visualisation of its iterations. All vertices of the graph are placed on a given circle in some order. The graph's edges are classified as either snakes or ladders, with snakes forming arcs of the circle and ladders forming its chords. The heuristic strives to place exactly n snakes on the circle, thereby forming a Hamiltonian cycle. The snakes and ladders heuristic (SLH) uses transformations, inspired by k-opt algorithms such as the classical Lin–Kernighan heuristic to reorder the vertices on the circle in order to transform some ladders into snakes and vice versa. The use of a suitable stopping criterion ensures the heuristic terminates in polynomial time, $O(n^4 \log n)$ for this implementation. (Monday 15:00)

Closed 2-cell embeddings under partial duality

Mark Ellingham* and Xiaoya Zha

Vanderbilt University

There is a standard notion of duality for graphs embedded on surfaces with every face homeomorphic to an open disc, which switches the roles of vertices and faces. In 2009 Chmutov introduced a "partial dual" operation, which takes an embedded graph G and $S \subseteq E(G)$ and constructs G^S, a new embedding of a new graph. If $S = E(G)$ then G^S is the standard dual. The topological consequences of Chmutov's operation have not yet been intensively investigated. One important property of embeddings is being "closed 2-cell," when the boundary of every face is a cycle in the graph. The standard dual of a closed 2-cell embedding is closed 2-cell, but partial duals may not be. We present necessary and sufficient conditions for a partial dual to be closed 2-cell.
(Thursday 16:30)

On decomposing regular graphs and multigraphs into isomorphic trees

Saad I. El-Zanati

Illinois State University

Let H and G be graphs or multigraphs such that G is a subgraph of H. A *G-decomposition* of H is a set $\Delta = \{G_1, G_2, \ldots, G_t\}$ of pairwise edge-disjoint subgraphs of H each of which is isomorphic to G and such that each edge of H occurs in exactly one G_i. Graham and Häggkvist have conjectured that every tree with n edges decomposes every $2n$-regular graph. This conjecture has been confirmed for a small number of cases. If G is a tree with n edges and H is n-regular, then G may or may not decompose H. For a simple graph H, we let ${}^2H$ denote the multigraph obtained by replacing each edge of H with two parallel edges. We have previously conjectured that if a G is a tree with n edges and H is an n-regular simple graph, then there exists a G-decomposition of ${}^2H$. In this talk, we report on some recent results related to variations of these conjectures. (Thursday 11:00)

Some divers observations on switching reconstruction (part 2)

Beáta Faller*, Paulette Lieby, Jeanette McLeod, and Brendan McKay

Australian National University

The classical reconstruction problem asks when a graph G can be reconstructed from its *deck*, where the deck consists of *cards* showing each of the vertex-deleted subgraphs of G. A number of infinite classes of graphs are known to be reconstructible in the classical problem. These include trees, for which Kelly proved reconstructibility in 1957. As discussed in part 1, there are variants of this problem where the cards instead show the equivalence classes of graphs obtained by *switching* G.

We study the problem of reconstructing trees for different types of switchings. First, we consider directed trees with a switching that reverses the directions at one vertex, and with the equivalence classes being the isomorphism classes. We show that for this problem, there is a small finite number of nonreconstructible trees. Next, we consider a variation of this problem, where the equivalence class of G is the union of the isomorphism classes of G and its converse graph. We hope to prove our current conjecture that for this problem, the number of nonreconstructible trees is also finite. We present similar results for reconstruction problems where the edges of a graph are coloured with two colours, and a switching interchanges the colours at one vertex. Here, equivalence can refer to "colour-preserving isomorphism", or to "colour-partition preserving isomorphism".

The talk will be self-contained.

(Thursday 11:30)

Trinity and minors for alternating dimaps

Graham Farr

Monash University

An *alternating dimap* is an embedded digraph such that, at each vertex, the edges around it go alternately into the vertex and out from it. Tutte introduced a relation on alternating dimaps which he called *trinity*, and which extends the duality relation on plane graphs. In this work we describe three *minor* operations on alternating dimaps which are analogous to the usual minor operations (deletion and contraction) on undirected graphs, and discuss their properties.

(Tuesday 16:00)

Cyclotomic orthomorphisms

David Fear* and Ian Wanless

Monash University

An *orthomorphism*, θ, is a permutation of $\mathbf{F}_q$ satisfying $x \mapsto \theta(x) - x$ is also a permutation. A *cyclotomic orthomorphism* of index k is an orthomorphism satisfying

$$\theta(x) = \begin{cases} 0 & \text{if } x = 0 \\ a_i x & \text{if } \eta(x) = \omega^i \end{cases} \tag{1}$$

where η is a multiplicative character of order k. We denote the set of all orthomorphisms of index k with $\mathcal{C}_k$. I will present my progress in regards to the following two open problems regarding cyclotomic orthomorphisms, which were posed by Anthony Evans in his book Orthomorphism Graphs of Groups:

Problem 1. *If $a|b$, $b|q-1$ we know that $\mathcal{C}_a(q) \subseteq \mathcal{C}_b(q)$. When do we have equality? When do we have inequality?*

Problem 2. *For p an odd prime, what types of orthomorphisms can be orthogonal to a non-linear cyclotomic orthomorphism of index e, $1 < e < p-1$? For $p \leqslant 11$ we know that only cyclotomic orthomorphisms of the same index are allowed.*

(Thursday 12:00)

Recent advances in the Degree/Diameter Problem for bipartite graphs

R. Feria Puron*, M. Miller and G. Pineda-Villavicencio

University of Newcastle

The *Degree/Diameter Problem* for bipartite graphs asks for the maximum number $N^b(\Delta, D)$ of vertices in a bipartite graph of maximum degree Δ and diameter D. The problem remains open, since the exact value of $N^b(\Delta, D)$ has only been determined in a very limited number of cases.

The well-known Bipartite Moore Bound, denoted by $M^b(\Delta, D)$, represents a general upper bound on $N^b(\Delta, D)$. Graphs whose order attains the Bipartite Moore Bound – called bipartite Moore graphs – are very scarce; they may only exist for a few values of D. Research efforts in this area has focused in two main directions. On one hand, the improvements to the upper bounds by proving the non-existence of bipartite graphs missing the Bipartite Moore Bound by a few vertices. On the other hand, the discovery of largest known graphs of given degree and diameter, which clearly leads to improvements to the lower bounds.

In this talk we present a general overview of the Degree/Diameter Problem for Bipartite Graphs, followed by some of our new recent results in the two aforementioned directions. We also refer to several related open problems.
(Monday 11:00)

A planar graph decomposition with applications to graph layout

Giuseppe Di Battista, Fabrizio Frati*, and János Pach

The University of Sydney

A *k-queue layout* of a graph $G(V, E)$ consists of a total ordering σ of V and of a partition of E into k sets, called *queues*, so that no two edges (u, v) and (w, z) in the same queue are such that $u <_\sigma w <_\sigma z <_\sigma v$. The *queue number* of G is the minimum k such that G has a k-queue layout.

We study the asymptotic worst-case behavior of the queue number of an n-vertex planar graph. Several classes of planar graphs, e.g. planar graphs with *bounded tree-width*, are known to have constant queue number. No super-constant lower bound is known for the problem. At FOCS '10, the authors proved that n-vertex planar graphs have $O(\log^4 n)$ queue number, thus improving upon the previous $O(\sqrt{n})$ upper bound. As a consequence of such a result and of a result of Dujmović et al., planar graphs admit 3D straight-line crossing-free grid drawings in $O(n \log^{16} n)$ volume, which improves upon the previous $O(n^{1.5})$ upper bound by Dujmović and Wood. The main ingredients of the FOCS '10 result are:

1. The proof that every internally-triangulated planar graph G has a 1-subdivision G' that can be augmented by the insertion of dummy edges to a *level-2-connected* planar graph H. An internally-triangulated planar graph H is level-2-connected if its *outerplanar levels* are 2-connected.

2. An algorithm to decompose a level-2-connected graph H into two smaller level-2-connected graphs H_1 and H_2, so that H_1 and H_2 share only a path and satisfy some strong structural properties.

3. An algorithm to construct a queue layout of a level-2-connected graph H, starting from inductively constructed queue layouts of H_1 and H_2. The layout algorithm heavily relies on the recursive use of the decomposition of a level-2-connected graph into two smaller level-2-connected graphs.

In this talk we show a new decomposition for planar graphs. It decomposes an input planar graph G into two smaller planar graphs G_1 and G_2, so that G_1 and G_2 both satisfy structural properties analogous to the ones guaranteed by the decomposition for level-2-connected planar graphs (mentioned at item (2) of the previous list). Such properties allow a recursive use of the decomposition to construct a queue layout of a planar graph (similarly to the algorithm mentioned at item (3) of the previous list). The new decomposition directly deals with the cut-vertices in the outerplanar levels of G, hence it does not require the edge-subdivision step (mentioned at item (1) of the previous list). The use of such a subdivision step implies losing a quadratic factor on the upper bound (as if a 1-subdivision G' of a graph G has queue number k, then G has queue number $O(k^2)$). Hence, our new planar graph decomposition leads to an improvement upon the bounds presented at FOCS '10. Namely, we get that n-vertex planar graphs have $O(\log^2 n)$ queue number and 3D straight-line crossing-free grid drawings in $O(n \log^8 n)$ volume. (Thursday 16:00)

Extremal vertex sets and their numbers

Serge Gaspers

The University of New South Wales and National ICT Australia

How many minimal (with respect to set containment) or maximal vertex subsets with a certain property can a graph on n vertices have at most? First bounds of this type date back to the 1960s when it was proved that the maximum number of maximal independent sets in any graph on n vertices is $\Theta(3^{n/3})$.

Recently, there has been a renewed surge of interest in such bounds. On one hand, they have become very helpful in the analysis of exponential time algorithms. On the other hand, methods developed to analyze exponential time algorithms can be used to derive such bounds as well.

In this talk, I will give an overview of bounds on extremal vertex sets in graphs. I will also use a potential function method – known as Measure & Conquer in exponential time algorithmics – to give a simpler proof showing that the number of minimal separators in any graph on n vertices is $O(\rho^n)$, where $\rho = \frac{1+\sqrt{5}}{2} = 1.6180\ldots$ is the golden ratio. The best known lower bound on the maximum number of minimal separators is $\Omega(3^{n/3})$. (Wednesday 10:00)

Completely regular codes with large minimum distance

Neil Gillespie

The University of Western Australia

In 1973 Delsarte introduced completely regular codes as a generalisation of perfect codes. Not only are completely regular codes of interest to coding theorists due to their nice regularity properties, but they also characterise certain families of distance regular graphs. Although no complete classification of these codes is known, there have been several attempts to classify various subfamilies. For example, Borges, Rifá and Zinoviev classified all binary non-antipodal completely regular codes. Similarly, in joint work with Praeger, we characterised particular families of completely regular codes by their length and minimum distance, and additionally with Giudici, we also classified a family of completely transitive codes, which are necessarily completely regular. In this work with Praeger, and also with Giudici, the classification given by Borges, Rifá and Zinoviev was critical to the final result. However, recently Rifá and Zinoviev constructed an infinite family of non-antipodal completely regular codes that does not appear in their classification. This, in particular, led to a degree of uncertainty about the results with Praeger and with Giudici. In this talk I demonstrate how I overcame this uncertainty by classifying all binary completely regular codes of length m and minimum distance δ such that $\delta > m/2$. (Tuesday 11:00)

Embedding spherical latin trades into abelian groups

Tony Grubman* and Ian Wanless

Monash University

The theory of latin bitrades has had many recent developments related to their embeddings into abelian groups. A *latin bitrade* (W, B) is the difference between two latin squares L_1 and L_2 of the same order, and W and B are both called *latin trades*. More precisely, if L_1 and L_2 are thought of as sets of entries (r, c, s) (representing symbol s in row r and column c), then $W = L_1 \setminus L_2$ and $B = L_2 \setminus L_1$. The equivalence of spherical latin bitrades and face 2-colourable triangulations of the sphere allows both combinatorial and graph theoretic techniques to be used in the study of these objects. Vertices in the triangulation correspond to rows, columns, and symbols, while faces correspond to entries in the bitrade (W, B) (white faces are entries in W, black faces are entries in B).

For a bitrade (W, B), fix an entry $(r_0, c_0, s_0) \in W$ and define the *canonical abelian group* $\mathcal{A}_W^*$ as the finitely presented abelian group with rows, columns, and symbols as generators, and $r + c + s = 0$ as relations for each $(r, c, s) \in W$, with the extra two relations $r_0 = s_0 = 0$. Cavenagh and Wanless showed that if (W, B) is spherical, then this group is finite and that W embeds into $\mathcal{A}_W^*$. They also posed several questions about the structure of $\mathcal{A}_W^*$, as well as minimal embeddings of W. An embedding of W into a group G is called *minimal* if W does not embed into any proper subgroups of G. Blackburn and McCourt recently solved some of these questions, but also asked several more.

In this talk, answers to some of these problems are provided through some examples inspired by constructions of triangulations. Three moves that increase the size of bitrades while preserving their genus are defined, and the equivalent operations on the graph are shown to generate every face 2-colourable triangulation of the sphere. Furthermore, only one of these operations is required when starting from *cycles*, which have a known, predictable structure for every size. Two of the operations are shown to always increase the order of the canonical group, while the third is shown to always double it. This is used to construct several families of spherical trades whose canonical groups grow faster (with respect to the size of the trade) than any previously studied examples. One of these also has minimal embeddings into groups exponentially smaller than the canonical group. These examples answer two of the open questions completely, provide a partial solution to another, and improve the bound for a constant in a fourth question. (Tuesday 12:00)

Treewidth of line graphs

Daniel Harvey* and David Wood

Department of Mathematics and Statistics, University of Melbourne

In recent structural graph theory results by Grohe and Marx, the treewidth of the line graph of the complete graph is a critical example. In fact, they show that, in some sense, every graph with large treewidth contains the line graph of a large complete graph as a minor. Grohe and Marx determined the treewidth of the line graph of a complete graph up to a constant factor. We determine it exactly. More generally, we determine the exact treewidth of the line graph

of any regular complete multipartite graph. For an arbitrary complete multipartite graph, we determine the treewidth of the line graph up to a lower order term. (Wednesday 10:00)

Elusive codes in Hamming graphs

Neil I. Gillespie, Daniel R. Hawtin* and Cheryl E. Praeger

University of Western Australia

We consider a *code* to be a subset of the vertex set of a *Hamming graph*. We examine *elusive pairs*, code-group pairs where the code is not determined by knowledge of its *set of neighbours*. We provide an infinite family of elusive pairs, where the group in question acts transitively on the set of neighbours of the code. In our examples, we find that the *alphabet size* always divides the *length* of the code, and prove that there is no elusive pair for the smallest set of parameters for which this is not the case.

Preprint available: `http://arxiv.org/abs/1208.4455` (Tuesday 10:00)

The application of donut graphs to the P1F problem for circulants

Sarada Herke* and Barbara Maenhaut

University of Queensland

A 1-factor (or perfect matching) of a graph G is a 1-regular spanning subgraph of G. A 1-factorisation of G is a decomposition of G into edge-disjoint 1-factors. If a 1-factorisation has the additional property that the union of any two of the 1-factors is a Hamilton cycle, then it is called a perfect 1-factorisation (which we abbreviate as P1F). A circulant graph is a Cayley graph on a cyclic group. We consider the problem of the existence of P1Fs of even order 4-regular circulant graphs. After observing that having order 0 (mod 4) is a necessary condition for the existence of a P1F of a bipartite circulant, we have found that the condition is not sufficient as there is a bipartite circulant graph of order 30 with no P1F. In this talk we define a class of 4-regular graphs which we call donut graphs. We discuss some of their properties and provide some P1F results for these graphs, which have useful implications for the P1F problem for circulant graphs.
(Monday 10:00)

Counting polynomials that satisfy the Eisenstein criterion

Randell Heyman

Macquarie University

The Eisenstein criterion is a well-known sufficient condition for the irreducibility of polynomials with integer (or rational) coefficients. But what is the chance that an irreducible polynomial can be shown to be irreducible by the Eisenstein criterion? In the last 13 years there has been progress in quantifying the probabilities that certain sets of polynomials satisfy the Eisenstein criterion. The talk will give some improved results for monic polynomials and some new results for the set of all polynomials of a maximum height, leading to a formula when the height approaches infinity. This involves a careful use of the inclusion/exclusion principle and also properties of arithmetic functions.

We will also cover some ongoing work on counting polynomials that can be "shifted." That is, they satisfy the Eisenstein criterion after an additive shift of the variable. We will also pose some open questions.

This is joint work with Igor Shparlinski. (Tuesday 15:00)

On an extension of difference matrices

Yutaka Hiramine

Kumamoto University

A $k \times u\lambda$ matrix $M = [d_{ij}]$ with entries from a group U of order u is called a (u, k, λ)-difference matrix over U if the list of quotients $d_{i\ell}{d_{j\ell}}^{-1}, 1 \leqslant \ell \leqslant u\lambda$, contains each element of U exactly λ times for all $i \neq j$. D. Jungnickel has shown that $k \leqslant u\lambda$ and it is conjectured that the equality holds only if U is a p-group for a prime p. On the other hand, A. Winterhof has shown that some known results on the non-existence of $(u, u\lambda, \lambda)$-difference matrices are extended to $(u, u\lambda - 1, \lambda)$-difference matrices. This fact suggests us that there is a close connection between these two cases. In this talk we show that any $(u, u\lambda - 1, \lambda)$-difference matrix over an abelian p-group can be extended to $(u, u\lambda, \lambda)$-difference matrix. (Thursday 16:00)

Fast random walk and its stationary distribution

Yusuke Hosaka*, Yukiko Yamauchi, Shuji Kijima, and Masafumi Yamashita

Kyushu University, Japan

Random walks have many applications, such as network searching, random sampling, self-stabilization of distributed systems, and so on. Their performances often depend on the properties of random walk, e.g., hitting time, cover time, stationary distribution, etc. Nonaka et al. showed that the hitting time of a Metropolis walk is bounded by $O((\pi_{\max}/\pi_{\min})\cdot n^2)$ for any graph, where n denotes the number of vertices and $\pi_{\max}$ (respectively, $\pi_{\min}$) denotes the maximum (respectively, minimum) value of the stationary distribution π of the chain. To obtain the desired distribution, the Metropolis walk usually contains many self-loop edges. Meanwhile, it is known that eliminating self-loop could decrease hitting and cover time of a graph. Motivated by a fast random walk, we discuss the relationship between the stationary distribution and the hitting/cover times, based on minimization of self-loop via linear programming.
(Monday 17:00)

On embedding a unitary block design as a polar unital and a new intrinsic characterization of the classical unital

Alice M. W. Hui* and Philip P. W. Wong

The University of Hong Kong

A *projective plane* of order m, $m > 1$, is a 2-$(m^2 + m + 1, m + 1, 1)$ design. A *polarity* ρ in a projective plane of order m is a correlation of order 2. A point x is *absolute* with respect to a polarity ρ if x is incident with x^ρ, and is *non-absolute* otherwise. An absolute line or a non-absolute line are defined dually. If m is a square and the polarity has $m^{3/2} + 1$ absolute points, then the polarity is called *unitary.*

A *unital* (or a unitary block design) $\mathcal{U}$ of order n, $n > 2$, is a 2-$(n^3 + 1, n + 1, 1)$ design. A unital of order n embedded in a projective plane π of order n^2 is called a *polar unital* if it consists of the absolute points and non-absolute lines of a unitary polarity of π. In particular, if π is the classical (Desarguesian) plane $PG(2, q^2)$, then the polar unital is called a classical unital.

In a classical unital there exists no O'Nan configuration (I), i.e. four lines intersecting in six points. Piper's conjecture states that this is sufficient for a classical unital. Wilbrink proves a weaker result by adding two conditions (II) and (III), concerning a notion of parallelism. Furthermore, if the order of the unital is even, (III) is a consequence of (I) and (II).

We give a necessary and sufficient condition (p) for embedding a unital into a projective plane as a polar unital. Basically, the condition is the existence for each line of a spread containing that line and a suitable notion of perpendicularity based on the existence. Under a strengthening (P) of (p) we show that all vertices satisfy Wilbrink's condition (II) in strong

form. Furthermore, we show that a unital satisfying (P) and Wilbrink's condition (III) is classical, thus giving a new intrinsic characterization without assuming the absence of O'Nan configurations. We study whether (III) is a consequence of the assumption that every vertex satisfies (II) in strong form.

We note that if a unital of even order satisfies (I) and (II) then it satisfies (P) and provide a proof using the geometry of inversive planes and without using classification of finite simple groups, i.e. Wilbrink's result. We also note that if a unital satisfies (P) then the ambient plane constructed is classical if the unital is classical.
(Tuesday 12:00)

Graph pebbling: new results and open problems

Glenn Hurlbert

Arizona State University

In this talk we give a short introduction to the subject of graph pebbling, including its history from combinatorial number theory, its growth as a purely graph theoretic topic, and its development into an area of combinatorial optimization. We shall describe some of its variations as well, such as optimal pebbling, cover pebbling, fractional pebbling, pebbling thresholds, and others, along with its connections to p-adic diophantine equations. Lastly, we will present a few of the major techniques in the field and offer some tantalizing open problems for further research. (Tuesday 10:00)

Asymptotic enumeration of Eulerian circuits and orientations for graphs with strong mixing properties

Mikhail Isaev

Ecole Polytechnique, France
Moscow Institute of Physics and Technology, Russia

We consider two enumeration problems: counting the number of Eulerian orientations and counting the number of Eulerian circuits in an undirected simple graph. It is known that both of these problems are complete for the class $\#P$ and, consequently, are difficult in terms of the complexity theory.

In this talk we give the asymptotic formulas for the numbers of Eulerian circuits and orientations for graphs with strong mixing properties and with vertices having even degrees. The exact values are determined up to the multiplicative error $O(n^{-1/2+\varepsilon})$ for Eulerian circuits and up to the multiplicative error $O(n^{-1+\varepsilon})$ for Eulerian orientations, where n is the number of vertices.

This talk is based on works [1], [2], [3].

[1] M. Isaev, *Asymptotic behaviour of the number of Eulerian circuits*, Electronic Journal of Combinatorics, 2011, V.18(1), P.219.

[2] M. Isaev, *Asymptotic enumeration of Eulerian circuits for graphs with strong mixing properties*, Izvestiya RAN. Seriya matematicheskaya (submitted), e-print arXiv:1210.2491.

[3] M. Isaev, *Asymptotic enumeration of Eulerian orientations for graphs with strong mixing properties*, Journal of Applied and Industrial Mathematics (submitted), e-print arXiv:1203.6880.
(Monday 11:30)

Bounds of antimagic constant for some families of trees

M. Javaid* and A. A. Bhatti

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Let $G = (V, E)$ be a graph with $v = |V(G)|$ vertices and $e = |E(G)|$ edges. An (a, d)-*edge-antimagic total* ((a, d)-EAT) *labeling* of a graph G is a bijective function $\lambda : V(G) \cup E(G) \to \{1, 2, \dots, v + e\}$ such that the set of edge-weights $\{w(xy) = \lambda(x) + \lambda(xy) + \lambda(y), xy \in E(G)\}$, form an arithmetic progression $\{a, a + d, a + 2d, \dots, a + (e - 1)d\}$, where $a > 0$ (antimagic constant) and $d \geqslant 0$ are two fixed integers. If such a labeling exists then G is said to be an (a, d)-*EAT graph*. If we assign the smallest labels to the vertices then it becomes super (a, d)-EAT labeling. In this paper, we find some results related to bounds of a (antimagic constant) for some families of trees.

Hadwiger's Conjecture for ℓ-link graphs

Bin Jia* and David Wood

The University of Melbourne

In this talk I will define and study a new family of graphs, which is a generalization of line graphs and path graphs. An ℓ-*link* is a walk of length $\ell \geqslant 0$ in a (multi)graph G such that any two consecutive edges are different. We identify an ℓ-link with its reverse sequence. The ℓ-link graph $\mathbb{L}_\ell(G)$ of G is the graph with vertices the ℓ-links of G, in which two vertices are adjacent if the union of their corresponding ℓ-links forms an $(\ell + 1)$-link. We give a sufficient and necessary condition for a graph to be isomorphic to an ℓ-link graph, which solves the characterization problem for path graphs to some extent. Based on this characterization, we show that Hadwiger's conjecture is true for a large family of ℓ-link graphs. (Tuesday 16:30)

Planar hypohamiltonian graphs on 40 vertices

Mohammadreza Jooyandeh*, Brendan D. McKay, Patric R. J. Östergård,
Ville Pettersson and Carol T. Zamfirescu

Australian National University

Bounding the order of the smallest planar hypohamiltonian graph has proved to be a challenging problem for the past four decades. Prior to the present study, the smallest known planar hypohamiltonian graph had 42 vertices, a result due to Araya and Wiener. We improve upon this by generating 25 planar hypohamiltonian graphs of order 40. Using this, we present planar hypotraceable graphs of order 154; previously, the smallest known example had 162 vertices. Moreover, it had been proven that there is a planar hypohamiltonian (hypotraceable) graph of order n for every $n \geqslant 76$ ($n \geqslant 180$). Using the new result obtained in this study, we decreased these bounds to 42 and 156, respectively. (Wednesday 11:00)

Lattice path counting without touching a line with no consecutive horizontal segments

Hyunwoo Jung

Korea Science Academy of KAIST

We consider a lattice path counting problem related to the ballot theorem. This problem is encountered in an online auction profit maximization problem to prove a performance of an auction algorithm [Immorlica et al. and Jung et al.]. In this paper, we consider the number of lattice paths without touching a line with no consecutive horizontal segments.

The original ballot problem is like the following.
The ballot problem: Suppose that in an election, candidate A receives n votes and candidate B receives k votes, where $n \geqslant sk$ for some positive integer s. Compute the number of ways that the ballots can be ordered so that A maintains more than s times as many votes as B throughout the counting of the ballots.
The ballot theorem: The solution to the ballot problem is $\frac{n-sk}{n+k}\binom{n+k}{k}$
The original ballot problem is the case when $s = 1$. For the integer $s \geqslant 1$, Barbier generalized the problem without proof. Later various proofs for the ballot problem has been found. In this paper we use a cycle lemma and hierarchical partitioning to prove a variant of the ballot theorem. The ballot problem can be seen as the number of lattice path problem from $(0, 0)$ to (k, n) without touching the line $y = sx$ after the point $(0, 0)$ and before (a, b). We can consider a lattice path from $(0, 0)$ to (k, n) as a sequence $p^0 p^1 p^2 \cdots p^t$ of vertices where $p^0 = (0, 0)$ and $p^t = (k, n)$ Let's define a x-strict lattice path as a lattice path where $p^1 = (0, 1)$ and no three consecutive vertices in the lattice path have the same x-coordinates. The number of x-strict lattice paths from $(0, 0)$ to (k, n) is $\binom{n}{k}$.

In this paper we prove a lower bound for the number of x-strict lattice paths from $(0, 0)$ to (k, n) that does not touch a line $y = \frac{n}{k}x$. Let $p(k, n)$ denote the number of lattice paths from coordinates $(0, 0)$ to (k, n) without touching the line $y = \frac{n}{k}x$ and with no horizontal segments

when $k < n$. In the paper by Jung et al., following statement about an upper bound is proved: $p(k,n) \leqslant \frac{1}{k}\binom{n-1}{k-1}$.
In this paper, by using a cycle lemma and hierarchical partitioning, we prove a weak lower bound for $p(k,n)$:
$p(k,n) \geqslant \frac{1}{k^2}\binom{n-1}{k-1}$

Our conjecture for a stronger lower bound for $p(k,n)$ is the following: $p(k,n) \geqslant \frac{1}{n}\binom{n-1}{k-1}$. This holds when $n \leqslant 20$ as a result of computer simulation. Interestingly, when k goes to n, the upper bound and the strong lower bound are almost tight. To prove the conjecture is open.
(Monday 15:00)

Accessibility number and total accessibility

Elgin Kiliç and Pinar Dündar

Ege University, Turkey

One of the most solved problems with the help of graph theory is to design a network model whose resistance for the disruptions is more than other networks. Many vulnerability measures have been defined over all vertices of a graph to this purpose. In recent years, measures are defined over some vertices or edges which have specific property. In this study Total Accessibility which is a new measure as the second type of measures using the some vertices of a graph having a special property is defined. Some results are found on general graph types and its relation between graph operations. An algorithm which calculates Total Accessibility of a graph is given. When any two networks having the same order and having the same value of some vulnerability measures are compared in stability, it is inferenced that network whose Total Accessibility value higher is more stable than the other.
(Friday 11:00)

Hitting time and cover time on dynamic graphs

Kosuke Koba*, Yukiko Yamauchi, Shuji Kijima and Masafumi Yamashita

Kyushu University, Japan.

Random walks on graphs have practical applications such as Internet crawlers, searching networks, and so on. There are many results on random walks on static networks. However, real networks, such as the Internet, are changing time by time, and it is a significant task to analyze random walks on dynamic graphs. This paper is concerned with random walks on dynamic graphs; given an undirected graph $G = (V, E)$, a graph $G^t = (V, E^t)$ at time t contains each edge $e \in E$ with an independent probability $1 - q$. On such dynamic graphs, we are concerned with a random walk based on the Metropolis-Hastings. We show that the hitting time and the cover time of the random walk on dynamic graphs are bounded by the hitting time and the cover time on static graphs, respectively. (Monday 16:30)

Insertion-triangulation techniques for solving the facility layout design problems

Yaya S. Kusumah* and Mieke Yolanda

Indonesia University of Education

The facility layout design problem is a fundamental optimization problem in many industrial settings, including the layout of machines and robots. The problem can be modelled as that of finding, in a given graph, an edge-weighted spanning subgraph that is planar. The NP-completeness of this problem has motivated some work on heuristics, particularly graph-theoretic based heuristics. An advantage of these algorithms is that there is no need to check planarity. In this talk, an algorithm for solving problems in the facility layout design problems, applying insertion-triangulation techniques in planar graphs, will be discussed.
(Wednesday 11:30)

On k-hamiltonicity of bipartite and tripartite graphs

Gee-Choon Lau*, Sin-Min Lee, Karl Schaffer and Siu-Ming Tong

Universiti Teknologi MARA (Segamat Campus), 85000 Johor, Malaysia

For a (p, q)-graph G, if the vertices of G can be arranged in a sequence $v_1, v_2, \ldots, v_p$ such that for each $i = 1, 2, , p - 1$, the distance for v_i and v_{i+1} equal to k, then the sequence is called a k-Hamiltonian sequence. Furthermore, if $d(v_{p+1}, v_1) = k$, we say G admits a k-Hamiltonian cycle and G is k-Hamiltonian. In this paper we (i) obtain necessary and sufficient condition for a cycle to be k-Hamiltonian; and (ii) completely determine which grid graphs are 3-Hamiltonian. (Thursday 12:00)

Suzuki groups are more chiral than regular

Isabel Hubard and Dimitri Leemans*

University of Auckland

The number of abstract regular polyhedra on which a Suzuki simple group $Sz(q)$ acts, with q an odd power of 2, was determined by Kiefer and Leemans in 2010. With Isabel Hubard, we determined the number of abstract chiral polyhedra for these groups and showed that there are much more chiral polyhedra than regular ones. We also have some results on higher rank polytopes for these groups. The main results we have are stated below.

Let $S \leqslant G \leqslant Aut(S)$ where S is the Suzuki group $Sz(q)$, with $q = 2^{2e+1}$ and e is a positive integer. Then,

1. There exists at least one chiral polyhedron with automorphism group isomorphic to G;
2. There are no chiral polytopes of rank five or higher with automorphism group G;
3. Up to isomorphism and duality, there are

$$\frac{\sum_{n|2e+1} \mu(\frac{2e+1}{n})(2^{2n})(2^n - 2)}{2e+1}$$

   chiral regular polyhedra whose automorphism group is the Suzuki group $Sz(q)$;

4. If there exists a chiral polytope of rank four with automorphism group G, then $G = S$ and $2e + 1$ is not a prime number.
5. Let $\mathcal{P}$ be a chiral 4-polytope such that the automorphism group $\Gamma(\mathcal{P}) := \langle \sigma_1, \sigma_2, \sigma_3 \rangle$ is S. Then $\langle \sigma_1, \sigma_2 \rangle \cong \langle \sigma_2, \sigma_3 \rangle \cong Sz(q')$ for some q' such that $q = q'^m$ with m an odd integer.

(Thursday 16:30)

Distinguishing graphs with intermediate growth

Florian Lehner

Graz University of Technology

The distinguishing number $d(G)$ of a graph G is the smallest number d such that there is a labelling of the vertices of G with n labels that is not preserved by any nontrivial automorphism of G. The motion $m(G)$ is the minimal number of vertices moved by a nontrivial automorphism. It is known that if G is finite and

$$m(G) \geqslant 2 \log |\operatorname{Aut} G|$$

then $d(G) \leqslant 2$.

We show that essentially the same holds true for locally finite graphs which do not grow too fast, partially verifying a conjecture of Tucker. More precisely, we prove that every locally finite graph with infinite motion and growth at most $\mathcal{O}\left(2^{(1-\varepsilon)\frac{\sqrt{n}}{2}}\right)$ is 2-distinguishable. (Thursday 10:00)

A time-evolving random network based on random geometric graphs and random motion

Natalya Levenkova

UNSW

We propose a model of a random network which combines ideas from random geometric graphs and random walks. The model produces a spatially-embedded, degree-inhomogeneous, time-evolving random network. In this talk we consider the one-dimensional discrete case of the model, in which vertices are uniformly distributed on a circle and each vertex is assigned a radius, drawn from a binomial distribution. We will look at several properties of simulated networks such as the number of connected components, clustering coefficient and degree distribution. (Tuesday 16:00)

Forcing number and anti-forcing number of fullerenes

Yuqing Lin

School of Electrical Engineering and Computer Science, The University of Newcastle

A fullerene graph, the molecular graph of a spherical fullerene, is a finite trivalent graph embedded on the surface of a sphere with only hexagonal and (exactly 12) pentagonal faces. Let F_n be a fullerene graph with n vertices and M be a perfect matching of F_n. The *forcing number* of a perfect matching M of F_n is the cardinality of the smallest subset of M that is contained in no other perfect matchings of F_n. The *anti-forcing number* is defined as the smallest number of edges that have to be removed in order that F_n remains with a single perfect matching. We have shown that the lower bound of the forcing number for fullerene is 3 and lower bound for the anti-forcing number of fullerene is 4. In this talk I will review these results and present some open questions.
(Friday 10:00)

Matching covered graphs with three removable classes

M.H. de Carvalho and C.H.C. Little*

Massey University

The notion of removable classes arises in connection with ear decompositions of matching covered graphs. The last (single or double) ear of an ear decomposition is defined as a removable class. Every matching covered graph not induced by a circuit has at least three removable classes. In this talk we characterise matching covered graphs with precisely three removable classes.
(Thursday 15:00)

Spectral properties of unitary Cayley graphs of finite commutative rings

Xiaogang Liu* and Sanming Zhou

The University of Melbourne

The *adjacency matrix* of a graph is the matrix with rows and columns indexed by its vertices such that the (i, j)-entry is equal to 1 if vertices i and j are adjacent and 0 otherwise. The *eigenvalues* of a graph are eigenvalues of its adjacency matrix. A r-regular graph is *Ramanujan* if the absolute value of every eigenvalue of it other than $\pm r$ is at most $2\sqrt{r-1}$. The *k-th spectral moment* of a graph G with n vertices and with eigenvalues $\lambda_1, \lambda_2, \ldots, \lambda_n$ is defined as

$$s_k(G) = \sum_{i=1}^{n} \lambda_i^k,$$

where $k \geqslant 0$ is an integer. The *energy* of G is defined as

$$E(G) = \sum_{i=1}^{n} |\lambda_i|.$$

Let R be a finite commutative ring. The unitary Cayley graph of R, denoted G_R, is the graph with vertex set R and edge set $\{\{a, b\} : a, b \in R, a - b \in R^\times\}$, where $R^\times$ is the set of units of R. In this talk, we give a necessary and sufficient condition for G_R to be Ramanujan, and a necessary and sufficient condition for the complement of G_R to be Ramanujan. We also give formulae for the spectral moments of G_R and that of its line graph, and compute the energy of the line graph of G_R. (Monday 16:30)

Homomorphically full reflexive graphs and digraphs

Jing Huang and Gary MacGillivray*

University of Victoria

A digraph G is *homomorphically full* if every homomorphic image of G is a subgraph of G. This class of digraphs arose in the study of whether a homomorphism from a given digraph G to a fixed digraph H can be factored through a fixed digraph Y. It is known that the homomorphically full irreflexive undirected graphs are precisely those that contain neither P_4 nor $2K_2$ as an induced subgraph. We show that the homomorphically full reflexive undirected graphs are precisely the reflexive threshold graphs, that is, the reflexive graphs that contain none of P_4, $2K_2$ and C_4 as an induced reflexive subgraph. We also characterize the reflexive semicomplete digraphs that are homomorphically full, and discuss the relationship of these digraphs and Ferrers digraphs. (Friday 11:00)

Cycle structure of autoparatopisms of quasigroups and Latin squares

Jayama Mahamendige* and Ian Wanless

Monash University

A Latin square L of order n is an $n \times n$ array containing n symbols from $[n] = \{1, 2, \ldots, n\}$ such that each element of $[n]$ appears once in each row and each column of L. Rows and columns of L are indexed by elements of $[n]$. The element in the i^{th} row and j^{th} column is denoted by $L(i, j)$.
The set of n^2 ordered triples, $O(L) = \{(i, j, L(i, j)); i, j \in [n]\}$ is called the orthogonal array representation of L.

Let $\theta = (\alpha, \beta, \gamma) \in S_n^3$, where S_n is the symmetric group acting on $[n]$. A new Latin square $\theta(L)$ is obtained by permuting rows, columns and symbols of L by α, β, γ respectively. The elements $\theta \in S_n^3$ are known as isotopisms and $\theta(L)$ are said to be isotopic to L. If $\theta(L) = L$, then θ is called an autotopism of L. If $\theta = (\alpha, \alpha, \alpha)$, then α is said to be an automorphism.

Let $\sigma = (\theta; \lambda) \in S_n \wr S_3$, where $\theta = (\alpha, \beta, \gamma)$. A Latin square L^σ is obtained by permuting triples of $O(\theta(L))$ by λ. For example, if (x, y, z) is a triple of L and $\theta = (\alpha, \beta, \gamma; (12))$ then $\sigma(x, y, z) = (\beta(y), \alpha(x), \gamma(z))$. The map σ is known as a paratopism of L. If $L^\sigma = L$, then σ is called an autoparatopism of L. Isotopism is one case of paratopism (ie when $\lambda = id$). Let $\mathrm{Atp}(n)$, $\mathrm{Aut}(n)$ and $\mathrm{Par}(n)$ be the set of all autotopisms, automorphisms and autoparatopisms of Latin squares of order n respectively.

The main question that I focus on is which elements of $S_n \wr S_3$ are realised as an autoparatopism of Latin squares. In other words, what is $\mathrm{Par}(n)$?
(Tuesday 11:30)

R-submodularity and negative correlation in graphs

Arun P. Mani

The University of Melbourne

It is well-known that the rank function of a matroid (and a graph) is submodular. In this talk, I will discuss a useful extension of this property called R-submodularity. I will talk about some results on R-submodularity for graphs along with its applications in proving correlation inequalties for subgraph counting problems, and mention some significant open questions.
(Thursday 15:00)

Geometric puncturing for linear codes over finite fields

Tatsuya Maruta

Osaka Prefecture University

An $[n, k, d]_q$ code is a linear code of length n, dimension k and minimum weight d over the field of q elements. A fundamental problem in coding theory is to find $n_q(k, d)$, the minimum length n for which an $[n, k, d]_q$ code exists for given q, k, d. An $[n, k, d]_q$ code is called *optimal* if $n = n_q(k, d)$. In this talk we generaize the geometric method for puncturing to construct new optimal linear codes. (Tuesday 12:00)

Bribery and manipulation in tournaments with uncertain information

N. Mattei*, J. Goldsmith, A. Klapper, M. Mundhenk

NICTA

We study the computational complexity of bribery and manipulation schemes for sports tournaments with uncertain information. We introduce a general probabilistic model for multi-round tournaments. We also consider several special types of tournament: cup; challenge (or caterpillar); and round robin where results carry over to the equivalent voting rules: sequential pair-wise elections, cup, and Copeland, when the set of candidates is exactly the set of voters. This restriction, that candidates equal voters, creates new difficulties for most existing algorithms. The complexity of bribery and manipulation are well studied, almost always assuming deterministic information about votes and results. When using probability we end up with an interesting set of combinatorial enumeration problems. We assume that for candidates i and j the probability that i beats j and the costs of lowering each probability by fixed increments are known to the manipulators. We provide complexity analyses for several problems related to manipulation and bribery for the various types of tournaments. Complexities range from probabilistic log space to NP^{PP}. This shows that the introduction of uncertainty into the reasoning process drastically increases the complexity of bribery problems in some instances. (Friday 11:00)

Extremal graph theory for book embeddings

Jessica McClintock

The University of Melbourne

A *book embedding* of a graph is a linear ordering of its vertices, and a partition of its edges into non-crossing sets (called *pages*). The *pagenumber* of a graph is the minimum number of pages for which it has a book embedding. There are many applications for book embeddings, mostly with regards to computer science and complexity theory.

A book embedding is *edge-maximal* if no edge can be added to the existing pages. In this talk I will prove that the minimum number of edges in a 3-page n-vertex edge-maximal book embedding equals $\lceil \frac{7n}{2} \rceil - 8$. Generalising to k pages, I give upper and lower bounds on the minimum number of edges in an edge-maximal book embedding.
(Wednesday 11:00)

Some divers observations on switching reconstruction (part 1)

Beáta Faller, Paulette Lieby, Jeanette McLeod, Brendan McKay* and Pascal Schweitzer

Australian National University

The classical reconstruction problem asks when a graph G can be reconstructed from its *deck*, where the deck consists of *cards* showing each of the vertex-deleted subgraphs of G. Stanley, Bondy and others introduced variants of this problem, where the cards instead show the results of *switching* G. There are many possible meanings for "switching" and we consider several. For example, the edges of G might be coloured with two colours and a switching involves interchanging the colours at one vertex, or changing the colour of one edge. Or, G might be a digraph and switching reverses the directions at one vertex, or reverses one edge.

In each case the cards show only equivalence classes of graphs, not labelled graphs, and the original graph needs to be reconstructed up to equivalence. Usually "equivalence" refers to graph isomorphism, but some interesting variants result from different definitions, such as considering the converse of a digraph to be equivalent to the original.

We give some examples and partial solutions to switching reconstruction problems. We then present a uniform abstraction that captures all the proposed variations and produces some surprisingly strong general consequences. (Thursday 11:00)

Some divers observations on switching reconstruction (part 3)

Beáta Faller, Paulette Lieby, Jeanette McLeod*, Brendan McKay and Pascal Schweitzer

University of Canterbury

The classical reconstruction problem asks when a graph G can be reconstructed from its *deck*, where the deck consists of *cards* showing each of the vertex-deleted subgraphs of G. Stanley, Bondy and others introduced variants of this problem, where the cards instead show the graphs obtained by *switching* G. There are many possible meanings for "switching" and we consider two. First, we let the edges of G be coloured with two colours and define the switching operation to be the interchange of the colours of the edges incident to a specified vertex. Then, we let G be a digraph and define the switching operation to be the reversal of the directions of the edges incident to a specified vertex.

In each case the cards show only equivalence classes of graphs, not labelled graphs, and the original graph needs to be reconstructed up to equivalence. Usually "equivalence" refers to graph isomorphism, but some interesting variants result from different definitions, such as considering the converse of a digraph to be equivalent to the original.

While investigating switching reconstruction problems, Bondy asked which graphs have the property that every possible switching produces a graph that is equivalent to the original graph. Such graphs are said to be *switching-stable*. We answer this question for the two types of switching defined above, and classify all switching-stable 2-edge-coloured graphs and all switching-stable digraphs. For both variants of switching, we consider the problem for two different types of equivalence. (Despite being part of a trilogy of talks, this talk will be self-contained.)
(Thursday 12:00)

Moore graphs and beyond: recent advances in the degree/diameter problem

Mirka Miller

University of Newcastle, Australia and University of West Bohemia, Czech Republic and King's College London, UK and ITB Bandung, Indonesia

The degree/diameter problem is to determine the largest graphs or digraphs of given maximum degree and given diameter. General upper bounds – called Moore bounds – for the order of such graphs and digraphs are attainable only for certain special graphs and digraphs.

Finding better (tighter) upper bounds for the maximum possible number of vertices, given the other two parameters, and thus attacking the degree/diameter problem 'from above', remains a largely unexplored area. Constructions producing large graphs and digraphs of given degree and diameter represent a way of attacking the degree/diameter problem 'from below'.

In this talk we present an overview of the problem area, some of the most recent new results, and several open problems.
(Monday 12:00)

Investigating the missing Moore graph

Marsha Minchenko* and Ian Wanless

Monash University

Moore graphs are regular graphs with diameter d and girth $2d+1$. Some well known examples are the Petersen graph and the Hoffman-Singleton graph. It is not known if the 57-regular Moore graph for $d = 2$ exists. If it does, then it is integral with spectrum $\{57, 7^{1729}, -8^{1520}\}$.

We look at how our equations that relate the spectral moments of a regular graph to the numbers of certain subgraphs can be used to investigate the missing Moore graph (MMG). With the aid of some basic counting arguments, these equations give further insights into the structure of the MMG such as the numbers of various theta graphs. We will also explore the problem of counting subgraphs in Moore graphs where $d = 2$ and give some of our results.
(Tuesday 17:00)

An approximation algorithm for routing and wavelength assignment on WDM 4-regular circulant networks

Heng-Soon Gan, Hamid Mokhtar* and Sanming Zhou

University of Melbourne

We present new results for the routing and wavelength assignment (RWA) problem on wavelength-division multiplexing (WDM) circulant networks for the all-to-all connection request set. Some special classes of the circulant networks were studied in the literature. In contrast, our work considers more general four-regular circulant networks. An approximation algorithm has been proposed for the edge- and arc-forwarding indices and wavelength assignment on the network. The algorithm gives a near optimal solution when a specific condition is satisfied for the network.
(Wednesday 10:00)

Small order spreads of $W(5, q)$

Sylvia Morris* and John Bamberg and Michael Giudici

University of Western Australia

Several infinite families and sporadic examples of symplectic spreads are known but these are far from a comprehensive list. For $q = 2$ there is a unique spread of $W(5, q)$, for $q = 3$ the symplectic spreads have been classified by Dempwolff and for $q = 4$ there is a connection between symplectic spreads and the unique ovoid of $Q^+(7, 4)$. I have been using linear programming methods to find spreads with non-trivial stabilisers in $W(5, 5)$ and $W(5, 7)$. I will survey previous results, discuss computational methods and give my results thus far, including some new non-semifield spreads.
(Tuesday 10:00)

Characterising infinite 1-searchable graphs

Alexander Muir

University of Newcastle

Pursuit-evasion based searching is a game played on a graph between an intruder and some number of searchers who attempt to capture the intruder. Originally inspired by the problem of searching for a spelunker lost in a cave, the game has a wide range of potential applications from firefighting to network security.

Much work has been done on characterising the graphs on which the intruder can be captured by just one searcher (such graphs are called 1-searchable), but these characterisations are not illuminating for infinite graphs. We present a number of necessary conditions for an infinite graph to be 1-searchable in terms of familiar structural features such as graph ends and local finiteness. (Monday 10:00)

Coalitional manipulation for Schulze's Rule

Serge Gaspers, Thomas Kalinowski, Nina Narodytska* and Toby Walsh

University of New South Wales

Schulze's voting rule is used in elections by a large number of organizations and contests, including the Wikimedia Foundation, the Pirate Party of Sweden and Germany, the Debian project and Top Coder. Schulze's rule is one of few voting rules that satisfies most of the desirable axiomatic properties, including monotonicity, majority, Condorcet consistency and independence of clones criteria.

One of the most important properties of a voting system is its resistance to manipulation from voters, where some voters might cast strategic votes instead of revealing their true preferences. Gibbrard-Sattertwhaite proved that most voting rules are manipulable. Bartholdi, Tovey and Trick (1989) introduced computational complexity as a barrier to manipulation. They showed that even if a manipulation exists, it may be computationally too difficult to find. Interestingly, most of the commonly used voting rules, including maximin, ranked pairs, Borda, 2nd order Copeland, STV, Nanson and Baldwin, etc., are resistant to manipulation with a small number of manipulators. In this work we study the computational complexity of Schulze's voting rule, which is arguably the most widespread Condorcet voting method in use today whose complexity to resist manipulation remains unknown.

The Schulze method computes the winners of elections based on finding paths in a directed graph labeled with the strength of defeats between pairs of candidates in pairwise elections. This graph is called the weighted majority graph. Such paths can be found using a variant of the Floyd-Warshall algorithm. Therefore, the manipulation problem can be seen as a problem of modifying labels of the graph using a set of additional voters profiles that changes the outcome of the election.

Firstly, we prove that Schulze's rule is vulnerable to weighted coalitional manipulation where each vote has an integer weight if the number of candidates is small. In particular, we show that if there exists a successful manipulation then there exists a manipulation where all manipulators cast the same vote. Second, we prove that unweighted coalitional manipulation is polynomial for any number of manipulators. This resolves an open question stated by Parkes and Xia (2012). Our proofs are all constructive and are based on the construction of specific out-branching trees of the weighted majority graph.
(Friday 11:30)

Inequivalence of difference sets

Padraig Ó Catháin

University of Queensland

Let G be a group of size v, and $D \subseteq G$ a subset of size k. Then D is a *difference set* if the multiset of quotients $\{d_i d_j^{-1} \mid d_i, d_j \in D\}$ contains every non-identity element of the group precisely λ times.

Difference sets are closely related to symmetric designs, Hadamard matrices, projective geometries and other combinatorial structures. Many constructions for difference sets are

known, but it is often difficult to show that difference sets obtained via different constructions are inequivalent. In this talk I will show that some well known families of $(4t-1, 2t-1, t-1)$ difference sets are inequivalent.   (Thursday 16:30)

Bounds on minors of binary matrices

Richard Brent and Judy-anne Osborn*

University of Newcastle

We prove an upper bound on sums of squares of minors of $\{+1, -1\}$ matrices. The bound is sharp for Hadamard matrices, a result due to de Launey and Levin (2009), but our proof is simpler. We give several corollaries relevant to minors of Hadamard matrices, and generalise a result of Turán on determinants of random $\{+1, -1\}$ matrices.   (Friday 11:30)

On the general position subset selection problem

Michael S. Payne* and David R. Wood

University of Melbourne

A set of points in the plane is in *general position* if it contains no three collinear points. The general position subset selection problem asks, given a finite set of points in the plane with at most ℓ collinear, how big is the largest subset in general position? That is, determine the maximum integer $f(n, \ell)$ such that every set of n points in the plane with at most ℓ collinear contains a subset of $f(n, \ell)$ points in general position. The problem has mainly been studied for fixed ℓ. Our work considered the problem for variable ℓ, and resulted in improved lower bounds when ℓ is around $\sqrt{n}$.

Recently Gowers asked a symmetric Ramsey style version of the general position subset selection problem on MathOverflow. Specifically, he asked for the minimum integer $\mathrm{GP}(q)$ such that every set of at least $\mathrm{GP}(q)$ points in the plane contains q collinear points or q points in general position, and he noted that $\Omega(q^2) \leqslant \mathrm{GP}(q) \leqslant O(q^3)$. The aim of this talk is to show that $\mathrm{GP}(q) \leqslant O(q^2 \ln q)$.   (Wednesday 11:30)

Finding manifolds by cycle decompositions

William Pettersson*, Ben Burton

University of Queensland

Manifolds are topological structures that are of interest to pure mathematicians, as well as researchers in other fields such as biology (DNA and knot theory), astronomy (determining the shape of the universe) and computational modelling (mesh generation). One particular problem in the study of manifolds is the enumeration of manifolds.

In this talk I will explain a new method of representing a manifold as a cycle decomposition of a graph. I will show how we can then translate various properties of the cycle decomposition into properties of the corresponding manifold, and how we can turn the problem of enumerating manifolds into one of enumerating cycle decompositions.
(Monday 15:00)

An application of completely separating systems to graph labeling

Mirka Miller, Oudone Phanalasy*, Joe Ryan and Leanne Rylands

University of Newcastle, Australia and National University of Laos, Laos

A *vertex antimagic edge labeling* of a graph $G(V, E)$ is a bijection $l : E \longrightarrow \{1, 2, \ldots, |E|\}$ such that all vertex weights are pairwise distinct, where the *weight* of a vertex is the sum of the labels of all the edges incident with that vertex. A graph is antimagic if it has a vertex antimagic edge labeling.

Let $[n] = \{1, 2, \ldots, n\}$. A *completely separating system* (CSS) on $[n]$ (or (n)CSS), is a collection $\mathcal{C}$ of subsets of $[n]$ in which for each pair of elements $a \neq b \in [n]$, there are two subsets A and B of $[n]$ in $\mathcal{C}$ such that A contains a but not b and B contains b but not a.

Recently, a relationship between completely separating system and antimagic labeling of certain graphs has been proved to exist. Based on this relationship some regular graphs have been proved to be antimagic.

In this talk, we review antimagic labelings for regular graphs using some results from CSSs. Then we extend the results to antimagic labelings for further families of regular and non-regular graphs. (Thursday 11:00)

On the degree/diameter problem for minor-closed graph classes

Guillermo Pineda-Villavicencio* and David R. Wood

University of Ballarat

In this talk I will report on recent progress on the degree/diameter problem for minor-closed graph classes, namely, given a minor-closed graph class $\mathcal{C}$ and bounds Δ and k for the degree and diameter of any graph in $\mathcal{C}$, respectively, find the maximum number $N(\Delta, k, \mathcal{C})$ of vertices that a graph of $\mathcal{C}$ can have. There is a well-known upper bound for $N(\Delta, k, \mathcal{C})$, the *Moore bound* (whose value is approximately Δ^k).

For the class $\mathcal{P}$ of planar graphs, we prove that, for any diameter $k \geqslant 2$ and $\Delta \geqslant \lfloor k/2 \rfloor$,

$$N(\Delta, k, \mathcal{P}) \leqslant \begin{cases} 91\,(27\Delta - 43)\,\frac{\Delta(\Delta-1)^{\lfloor k/2\rfloor - 1} - 2}{\Delta - 2} & \text{if } k \text{ is odd} \\ 9\,(6\Delta - 1)\,\frac{\Delta(\Delta-1)^{\lfloor k/2\rfloor - 1} - 2}{\Delta - 2} & \text{if } k \text{ is even} \end{cases}$$

For the class $\mathcal{G}(\Sigma)$ of graphs embeddable in a surface Σ of genus g, we construct graphs assuring

$$N(\Delta, k, \mathcal{G}(\Sigma)) \geqslant \sqrt{\frac{3}{8} g}\,\Delta^{\lfloor k/2 \rfloor}.$$

Our results imply that $\lim_{\Delta\to\infty} \frac{N(\Delta,k,\mathcal{P})}{\Delta^{\lfloor k/2\rfloor}}$ is a constant independent of Δ or k, and that

$$\sqrt{\frac{3}{8} g} \leqslant \lim_{\Delta\to\infty} \frac{N(\Delta, k, \mathcal{G}(\Sigma))}{\Delta^{\lfloor k/2 \rfloor}} \leqslant 6k(g+1) + 3.$$

This partially answers a question posed by Šiagiová and Simanjuntak in 2004 asking for the value of $\lim_{\Delta\to\infty} \frac{N(\Delta,k,\mathcal{G}(\Sigma))}{\Delta^{\lfloor k/2\rfloor}}$.

Furthermore, our results also answer in the negative an open problem by Miller and Širáň asking to prove or disprove that, for each surface Σ and each diameter $k \geqslant 2$, there exists a constant Δ_0 such that, for maximum degree $\Delta \geqslant \Delta_0$, $N(\Delta, k, \mathcal{G}(\Sigma)) = N(\Delta, k, \mathcal{P})$.
(Monday 11:30)

Maximum sized binary matroids with no $AG(3,2)$ minor

Dillon Mayhew, Gordon Royle, and Irene Pivotto*

University of Western Australia

A simple binary matroid of rank r corresponds to a set of vectors in $GF(2)^r$. We will define the notion of a *minor*, which is a natural partial order on matroids. We characterize the binary matroids of maximum size which do not contain $AG(3,2)$ (the affine geometry over $GF(2)^4$) as a minor. We show that, for every r, the unique such maximum size binary matroid arises from K_{r+1}. This generalizes a previous result by J. Kung.

We will present all the results in geometric terms; no prior knowledge of matroid theory will be assumed.
(Monday 11:00)

Full critical sets of full latin squares

Vaipuna Raass

University of Waikato

A multi-latin square of order n and index k is an $n \times n$ array of multisets of cardinality k such that each symbol from a set of size n occurs at most k times in each row and k times in each column. A full latin square of order n is the multi-latin square of order n and index n with each symbol occurring once in each cell. A full critical set of order n is a partial multi-latin square of order n and index n with an unique completion to a multi-latin square which is full, and each cell is either full or empty. Critical sets of full latin squares are analogous to minimal defining sets of full designs which have recently been studied (Akbari, Maimani, Maysoori (1993)), (Donovan, Lefevre, Waterhouse (2009)), and (Kolotoglu, Yazici (2010)). In particular, the intersection of a critical set of a full latin square of order n with a latin square of the same order gives a defining set of the latin square.

In this talk we present a formula for the size of a full critical set of the full latin square of order n. (Tuesday 11:00)

Alpha-labellings of trees with maximum degree 3 and a perfect matching

Michael Reynolds

University of Newcastle, Australia

Integer labellings of graphs that induce edge-labellings (via the absolute value of the difference between the 2 associated vertices) are an active area of current research. We will discuss the case of alpha-labellings of trees with maximum vertex degree 3 and a perfect matching, and examine present theoretical and computed results, as well as the prospect of future progress (Thursday 11:30)

The Merino-Welsh Conjecture for series-parallel graphs

Gordon Royle

University of Western Australia

The Merino-Welsh conjecture states that the number of spanning trees $\tau(G)$ in a graph G is dominated either by the number of acyclic orientations $\alpha(G)$ of the graph, or by the number of totally cyclic orientations $\alpha^*(G)$ of the graph. Special cases of the conjecture have been proved when the graph is very dense (where $\alpha^*(G) > \tau(G)$) or very sparse (where $\alpha(G) > \tau(G)$). However in some sense, the real difficulty of the conjecture lies "in the middle", when $|E(G)| \approx 2(|V(G)| - 1)$ and it is provably not sufficient to consider α or α^* in isolation.

In this talk, I report on joint work with Steve Noble, of Brunel University, London, where we resolve the conjecture for the class of series-parallel graphs. While the class of series-parallel graphs is small, their densities are centred exactly around the most-difficult densities for the resolution of the conjecture.
(Tuesday 15:00)

Degree Diameter Maximum Subgraph Problem

Joe Ryan

University of Newcastle

In this talk we will investigate a variation of the Degree/Diameter Problem where we seek the largest graph subject not just to constraints on diameter and maximum degree but embedded within a given host graph. In particular we will look at embeddings in the 2 and 3 dimensional rectangular grid as well as in the 2 and 3 dimensional hexagonal network.
(Friday 10:00)

Multipliers of difference sets

Ka Hin Leung, Siu Lun Ma, Bernhard Schmidt*

Nanyang Technological University, Singapore

A $(\boldsymbol{v}, \boldsymbol{k}, \boldsymbol{\lambda}, \boldsymbol{n})$ **difference set** in a finite group G of order v is a k-subset D of G such that every element $g \neq 1$ of G has exactly λ representations $g = d_1 d_2^{-1}$ with $d_1, d_2 \in D$. The positive integer $n = k - \lambda$ is called the **order** of the difference set. An integer t is a **multiplier** of D if $\{d^t : d \in D\} = \{dg : d \in G\}$ for some $g \in G$.

The well-known Multiplier Conjecture asserts the following. Let D be a (v, k, λ, n) difference set in an abelian group. If p is a prime dividing n, but not v, then p is a multiplier of D. Significant results on this problem, the multiplier theorems, were obtained by Hall, Ryser, and McFarland.

McFarland's approach relies on conditions guaranteeing the nonexistence of nontrivial solutions of group ring equations of the form $XX^{(-1)} = u^2$. We obtain progress towards the Multiplier Conjecture by providing new conditions of this kind.
(Thursday 17:00)

Codes over rings and matroids

Keisuke Shiromoto

Kumamoto University, Japan

We consider a class of generalizations of matroids, called demi-matroids, which have a duality property. This talk shall give a construction of demi-matroids from linear codes over finite quasi-Frobenius rings. Then we apply some results on demi-matroids to linear codes over these rings and show duality theorems such as a MacWilliams type duality.
(Monday 10:00)

The total run length of a word

Amy Glen and Jamie Simpson*

Murdoch University

A *run* in a word is a periodic factor whose length is at least twice its period and which cannot be extended to the left or right without increasing the period. In recent years a great deal of work has been done on estimating the maximum number of runs that can occur in a word of length n. A number of associated problems have also been investigated. In this talk we consider a new variation on the theme. We say that the *total run length* of a word is the sum of the lengths of the runs in the word and that $\tau(n)$ is the maximum of this over all words of length n. We show that $n^2/8 < \tau(n) < 47n^2/72 + 2n$ for all n. We also give a formula for the average total run length of words of length n over an alphabet of size α, and some other results. (Friday 10:00)

Generalising the clique-coclique bound

Murray Smith* and John Bamberg

University of Western Australia

A clique of a graph is a complete subgraph, and a coclique is an empty subgraph. For distance-regular graphs, the product of the size of a clique and the size of a coclique is at most the order of the graph. This is the Clique-Coclique Bound, and is known in coding theory as the sphere-packing bound. Focusing on strongly regular graphs, we prove a generalised form of the Clique-Coclique Bound which holds for weighted versions of these concepts, which we call supercliques and supercocliques. We prove that some families of strongly regular graphs permit supercliques and supercocliques meeting the generalised Clique-Coclique Bound. (Monday 16:00)

The trouble with network motifs: an analytical perspective.

Michael Brand and Douglas S. Stones*

School of Mathematical Sciences, Monash University

Network motifs are network sub-structures which occur with a significantly higher frequency than in randomised networks.

Mainstream methods for discovering network motifs rely implicitly on assumptions of independence between candidates and a normal distribution of the frequency counts. We show these assumptions to be critically incorrect.

Furthermore, we show that definitions which have been conflated in the literature, e.g. frequency-based vs. concentration-based statistics and high-frequency vs. low-probability motifs, lead to diametrically opposite conclusions and, indeed, to ill-defined concepts.
(Tuesday 16:30)

Class regular symmetric transversal designs with point semiregular automorphism groups

Chihiro Suetake

Oita University

In this talk I give a description of generalized Hadamard matrices corresponding to class regular symmetric transversal designs with some point semiregular automorphism groups. As an application, I treat class regular $\mathrm{STD}_{2^p}[2^p(2^p-1); 2^p-1]$'s with a point regular automorphism group, where 2^p-1 is a Mersenne prime. Especially, I construct a GH(7,8) over $(GF(7),+)$. This supplements one of gaps of a construction by W. de Launey and J. E. Dawson for $\mathrm{GH}(u,8)$'s. (Tuesday 16:00)

Independent spanning trees of Cayley graph of transposition tree

Hideaki Suto* and Toshinori Yamada

Graduate School of Science and Engineering, Saitama University

Let G be a connected graph, and $V(G)$ and $E(G)$ denote the vertex and the edge set of G, respectively. Let T and T' be two spanning trees of G, and r be a vertex in G. T and T' are called independent spanning trees, ISTs for short, rooted at r if, for any vertex $v \in V(G)$, the unique path connecting r and v on T and that on T' are internally vertex-disjoint. It is important to find ISTs of a given graph as many as possible because ISTs can be used for a fault-tolerant oblivious broadcasting on a network represented by the graph.

A graph G is said to be k-connected if the graph obtained from G by deleting any $k-1$ vertices is connected. Menger's Theorem states that a graph G is k-connected if and only if G has k internally vertex-disjoint path connecting any pair of vertices. Thus, If G has k ISTs rooted at r for any vertex $r \in V(G)$ then G is k-connected. However, it is open whether any k-connected graph G has k ISTs rooted at r for any vertex $r \in V(G)$, which is conjectured by Zehavi and Itai [A. Zehavi and A. Itai, "Three Tree-Paths," J. Graph Theory, vol.13, pp.175–188, 1989].

In our last year's talk, the n-star graph was shown to have $n-1$ ISTs rooted at r for any vertex $r \in V(S_n)$. In this talk, the above result is generalized so that a Cayley graph of a transposition tree of order n, which is $(n-1)$-connected, has $n-1$ ISTs rooted at r for any vertex $r \in V(S_n)$. (Thursday 10:00)

Non-classical polar unitals in finite Dickson semifield planes

M.W. Hui, H.F. Law, Y.K. Tai* and P.P.W. Wong

The University of Hong Kong

A unital is a $2-(n^3+1, n+1, 1)$ design. A semifield is a division algebra with associativity not assumed. The Dickson semifield $\mathcal{K}(\sigma)$ is commutative and parametrized by a field automorphism σ of $\mathbb{F}_q$. The associated Dickson semifield plane $\Pi(\mathcal{K}(\sigma))$ admits a unitary polarity ρ induced by an involutory automorphism α of $\mathcal{K}(\sigma)$. In 1972, Ganley showed that any unitary polarity of $\Pi(\mathcal{K}(\sigma))$ is determined by an autotopism (A, B, C) of $\mathcal{K}(\sigma)$ with $A^2 = id$ and $BC = id$. In the case of ρ, $A = B = C = \alpha$. Using an earlier result of Sandler concerning autotopism, we show that every unitary polarity of $\Pi(\mathcal{K}(\sigma))$ is determined by an autotopism of the form $(\alpha, a\alpha, a^{-1}\alpha)$, for $a \in \mathbb{F}_q^*$, and is conjugate to ρ. There is thus just one class of Dickson-Ganley polar unitals, which we refer to as the Dickson-Ganley Unital $\mathcal{U}(\sigma)$. We give two proofs that every Dickson-Ganley unital is non-classical, extending a result of Ganley's (1972).
(Tuesday 11:00)

Balanced (C_9, C_{14})-foil designs and related designs

Kazuhiko Ushio

Kinki University

Let K_n denote *the complete graph* on n vertices. Let C_9 and C_{14} be *the* 9-*cycle* and *the* 14-*cycle*, respectively. *The* (C_9, C_{14})-2t*-foil* is a graph of t edge-disjoint C_9's and t edge-disjoint C_{14}'s with a common vertex and the common vertex is called *the center of the* (C_9, C_{14})-2t*-foil*. When K_n is decomposed into edge-disjoint sum of (C_9, C_{14})-2t-foils and every vertex of K_n appears in the same number of (C_9, C_{14})-2t-foils, we say that K_n *has a balanced* (C_9, C_{14})-2t*-foil decomposition* and this number is called *the replication number*. This decomposition is to be known as *a balanced* (C_9, C_{14})-2t*-foil design*.

Theorem 1. K_n has a balanced (C_9, C_{14})-$2t$-foil design if and only if $n \equiv 1 \pmod{46t}$.
Theorem 2. K_n has a balanced C_{23}-t-foil design if and only if $n \equiv 1 \pmod{46t}$.
Theorem 3. K_n has a balanced C_{46}-t-foil design if and only if $n \equiv 1 \pmod{92t}$.
Theorem 4. K_n has a balanced C_{69}-t-foil design if and only if $n \equiv 1 \pmod{138t}$.
Theorem 5. K_n has a balanced C_{92}-t-foil design if and only if $n \equiv 1 \pmod{184t}$.
Theorem 6. K_n has a balanced C_{115}-t-foil design if and only if $n \equiv 1 \pmod{230t}$.
Theorem 7. K_n has a balanced C_{138}-t-foil design if and only if $n \equiv 1 \pmod{276t}$.
Theorem 8. K_n has a balanced C_{161}-t-foil design if and only if $n \equiv 1 \pmod{322t}$.
Theorem 9. K_n has a balanced C_{184}-t-foil design if and only if $n \equiv 1 \pmod{368t}$.
Theorem 10. K_n has a balanced C_{207}-t-foil design if and only if $n \equiv 1 \pmod{414t}$.
Theorem 11. K_n has a balanced C_{230}-t-foil design if and only if $n \equiv 1 \pmod{460t}$.
(Tuesday 16:30)

Public key authentication schemes using polynomials over non-commutative groups

Maheswara Rao Valluri

Fiji National University, Fiji Island

Authentication is a process by which an entity establishes its identity to another entity. In private and public computer networks, authentication is commonly done through the use of logon passwords. Knowledge of the password is assumed to guarantee that the user is authentic. Internet business and many other transactions require a more stringent authentication process.

In the recent years several authors proposed cryptographical protocols based on generic algebraic systems, especially non-commutative algebraic systems attract more attentions. So far, most cryptosystems using non-commutative algebraic systems are related to the difficulty of solving conjugate search problem (CSP) over certain non-abelian groups. Although there are algorithms for solving some variants of CSP in certain groups, such as braid groups, none of them can solve CSP itself defined over general non-abelian group in polynomial time with respect to the system parameters. In 2007, Cao et al. proposed a new method for designing

public key cryptosystems based on general non-commutative rings. This enables us to construct two-pass challenge-response and iterated three-pass challenge-response authentication schemes.

In this presentation, I will introduce Diffie-Hellman and Fiat-Shamir like authentication schemes based on general non-commutative group. The key idea of our proposals is that for given non-commutative group, we can define polynomials and take them as the underlying work structure. By doing so, it is easy to implement our authentication schemes. The security of the proposed schemes is based on the intractability of the polynomial symmetrical decomposition problem over the given non-commutative group.
(Tuesday 11:30)

The order of quasigroup automorphisms

Brendan McKay, Ian Wanless*, Xiande Zhang

Monash University

In 1974 Horoševskiĭ proved that no group of finite order n possesses an automorphism of order more than $n-1$. In this talk I will consider whether this result generalises to quasigroups. A quasigroup is a set with a binary operation satisfying the cancellation laws $ax = ay \Rightarrow x = y$ and $xa = ya \Rightarrow x = y$. The Cayley table of a quasigroup is a Latin square, so our results can also be phrased in terms of automorphisms of Latin squares. (Monday 16:30)

The geometry of inversive planes and the automorphism group of the Dickson-Ganley unitals

M.W. Hui, H.F. Law, Y.K. Tai and P.P.W. Wong*

The University of Hong Kong

We construct from a Dickson-Ganley polar unital $\mathcal{U}(\sigma)$, parametrized by a field automorphism σ, a design which is isomorphic to the residual design of a classical inversive plane. The link between the geometry of Dickson semifield plane and classical inversive plane allows us to associate to an isomorphism between two Dickson-Ganley polar unitals an automorphism of the residual design. This in turn determines an isotopism between the corresponding Dickson semifields, so that $\mathcal{U}(\sigma_1)$ is isomorphic to $\mathcal{U}(\sigma_2)$ if and only if $\sigma_1 = \sigma_2$ or $\sigma_1 = \sigma_2^{-1}$, and provides an extrinsic proof that $\mathcal{U}(\sigma)$ is not classical. Furthermore, we prove that the isotopism gives rise to an isomorphism between the unitals which extends to an isomorphism between the ambient Dickson semifield planes. As a consequence we conclude that the automorphism group of $\mathcal{U}(\sigma)$ equals the collineation subgroup of the ambient plane stabilizing the unital.
(Tuesday 11:30)

Nonrepetitive colouring via entropy compression

Vida Dujmović, Gwenaël Joret, Jakub Kozik and David R. Wood*

Monash University

A vertex colouring of a graph is *nonrepetitive* if there is no path whose first half receives the same sequence of colours as the second half. It is known that every graph with maximum degree Δ is $c\Delta^2$-colourable, for some constant c. First proved with $c \approx 17,000,000$, this constant has been subsequently lowered, most recently to $c = 12.92$. We prove it with $c = 1$ (ignoring lower order terms). While all previous results rely on the Lovász Local Lemma, our proof is based on the Moser-Tardos entropy-compression method, which is of independent interest. (A preprint is available at `arXiv:1112.5524`). (Thursday 10:00)

The enumeration of independent sets on some lattices

Zuhe Zhang

University of Melbourne

The study of lattice statistics in statistical physics has a long history. A typical problem is to count the ways of putting particles in the sites of a plane lattice such that no two share the same site or are in adjacent sites. Such problems are called the planar lattice gases models. Mathematicians formulated them by the enumeration of the $(0, 1)$ matrices which describe the independent sets in a plane quadratic lattice graph (also called a planar grid graph). Calkin and Wilf proved the existence of the entropy constant of plane quadratic lattice and established its upper and lower bounds. Two natural problems are to consider the entropy constants for lattices on cylinder or torus. Note that the method of Calkin and Wilf's is valid for the lattices with the same symmetric transfer matrices in both horizontal and vertical directions. In this talk, firstly we show that the entropy constants of the number of independent sets on certain plane lattices are the same as the entropy constants of the corresponding cylindrical and toroidal lattices. Secondly, we consider three more complex lattices which can not be handled by a single transfer matrix as in the plane quadratic lattice case. By introducing the concept of transfer multiplicity, we obtain the lower and upper bounds of the entropy constants of crossed quadratic lattice, generalized aztec diamond lattice and 8-8-4 lattice.
(Monday 12:00)

A hybrid algorithm for sampling graphs with given degree sequence

James Zhao

Stanford University

In studying real-world graphs, one is often faced with the problem of uniformly sampling graphs with given degree sequence. There are two main approaches to this problem—direct sampling, which works well for sparse graphs but can experience exponentially bad behaviour for dense graphs, and Markov Chain Monte Carlo (MCMC), which always has polynomial runtime, but carries the usual MCMC drawback of being difficult to decide when to stop. In this talk, I will present a hybrid algorithm that attempts to achieve the best of both worlds. The underlying idea—directly sample from a superset for which this is easy, then run MCMC until the desired subset is reached—can be extended to many combinatorial structures other than graphs. (Monday 16:00)

Monday

Time	OMB-149	OMB-145	OMB-144
09:00	**Aharoni**		
10:00	Muir	Herke	Shiromoto
10:30	Morning Tea		
11:00	Albert	Feria Puron	Pivotto
11:30	Isaev	Pineda-Villavicencio	Cameron
12:00	Zhang	Miller	Brettell
12:30	Lunch		
14:00	**Horsley**		
15:00	Jung	Pettersson	Ejov
15:30	Afternoon Tea		
16:00	Zhao	Cavenagh	Smith
16:30	Koba	Wanless	Liu
17:00	Hosaka		Corr

Tuesday

Time	OMB-149	OMB-145	OMB-144
09:00	**Thomassen**		
10:00	Hurlbert	Morris	Hawtin
10:30	Morning Tea		
11:00	Raass	Tai	Gillespie
11:30	Mahamendige	Wong	Valluri
12:00	Grubman	Hui	Maruta
12:30	Lunch		
14:00	**O'Keefe**		
15:00	Royle	Connor	Heyman
15:30	Afternoon Tea		
16:00	Suetake	Farr	Levenkova
16:30	Ushio	Jia	Stones
17:00	Demirkale	Ahmad	Minchenko
17:30	CMSA AGM		

Wednesday

Time	OMB-149	OMB-145	OMB-144
09:00	**Rodger**		
10:00	Harvey	Gaspers	Mokhtar
10:30	Morning Tea		
11:00	Jooyandeh	McClintock	Brankovic
11:30	Dehkordi	Payne	Kusumah
12:00	Excursion		

Thursday

Time	OMB-149	OMB-145	OMB-144
09:00	**Ruskey**		
10:00	Lehner	Wood	Suto
10:30	Morning Tea		
11:00	El-Zanati	McKay	Phanalasy
11:30	Billington	Faller	Reynolds
12:00	Fear	McLeod	Lau
12:30	Lunch		
14:00	**Conder**		
15:00	Little	Barat	Mani
15:30	Afternoon Tea		
16:00	Alspach	Frati	Hiramine
16:30	Leemans	Ellingham	Ó Catháin
17:00	Devillers	Eades	Schmidt
18:30	Conference Dinner		

Friday

Time	OMB-149	OMB-145	OMB-144
09:00	**Yeo**		
10:00	Simpson	Lin	Ryan
10:30	Morning Tea		
11:00	MacGillivray	Mattei	Kiliç
11:30	Osborn	Narodytska	
12:00	Brent	Aziz	

UNSW AUSTRALIA

Kensington Campus Map

Coogee →

1. Welcome Reception
   School of Mathematics & Statistics
   Red Centre Building - East Wing (H15)
2. Talks
   OMB 144/145/149
   Old Main Building (K15)
3. New College (L6)
4. New College Village (H3)
5. UNSW Village (B10)

Services

IT Service Desk (F21)
Library (E21)
Post Office (F22)
Print Post Plus (P³) - Printing Services (F23)

Religious Centre (E4)
Swimming Pool (B4)
UNSW Bookshop (E15)
UNSW Sports & Recreation (B5)