REPUBLIKA SLOVENIJA
MINISTRSTVO ZA IZOBRAŽEVANJE, ZNANOST IN ŠPORT

Symmetries of Graphs and Networks IV
and
2014 PhD Summer School in Discrete Mathematics

Rogla, Slovenia, June 29 – July 5, 2014

Operacijo delno financira Evropska unija, in sicer iz Evropskega socialnega sklada. Projekt se izvaja v okviru Operativnega programa razvoja človeških virov 2007-2013, razvojne prioritete 3: "Razvoj človeških virov in vseživljenjskega učenja"; prednostne usmeritve 3.3 "Kakovost, konkurenčnost in odzivnost visokega šolstva".

WELCOME

Dear Colleagues.

Some of us have gathered here for the sixth consecutive year. What was started as an informal research collaboration has now grown into a colorful series of international workshops and summer schools. We are glad to see many participants returning and several new ones joining the creative atmosphere of this event, which we will try to keep as relaxed and uplifting as in previous years. The organization of the meeting comes as a combined effort of the Andrej Marušič Institute (UP IAM) and the Faculty of Mathematics, Natural Sciences and Information Technologies (UP FAMNIT), two members of the University of Primorska, and is in line with our goal to create an international research center in algebraic combinatorics in this part of the world.

We wish you a pleasant and mathematically fruitful week at Rogla.

Dragan Marušič, Rector of the University of Primorska
Vito Vitrih, Director of UP IAM
Klavdija Kutnar, Dean of UP FAMNIT
Primož Šparl, Centre for Discrete Mathematics UL PeF

General Information

Symmetries of Graphs and Networks IV and 2014 PhD Summer School in Discrete Mathematics

Hotel Planja, Rogla, Slovenia, June 29 – July 5, 2014.

Organized by UP FAMNIT *(University of Primorska, Faculty of Mathematics, Natural Sciences and Inf. Technologies)* and UP IAM *(University of Primorska, Andrej Marušič Institute)*. In Collaboration with Centre for Discrete Mathematics, UL PeF *(University of Ljubljana, Faculty of Education)*.

Invited Speakers:

Marston Conder, *University of Auckland, New Zealand*
Shaofei Du, *Capital Normal University, China*
Yan Quan Feng, *Beijing Jiaotong University, China*
Michael Giudici, *University of Western Australia, Australia*
Isabel Hubard, *IMATE-UNAM, Mexico*
György Kiss, *Eötvös Loránd University, Hungary*
Young Soo Kwon, *Yeungnam University, South Korea*
Luis Martínez Fernández, *University of the Basque Country, Spain*
Joy Morris, *University of Lethbridge, Canada*
Paul Terwilliger, *University of Wisconsin-Madison, USA*
Egon Schulte, *Northeastern University, USA*
Tamás Szőnyi, *Eötvös Loránd University, Hungary*
Steve Wilson, *Northern Arizona University, USA*
Dave Witte Morris, *University of Lethbridge, Canada*

PhD Summer School in Discrete Mathematics Minicourses:

Construction techniques for graph embeddings
Mark Ellingham, *Vanderbilt University, USA*
Combinatorial designs
Mariusz Meszka, *AGH University of Science and Technology, Poland*
Symmetric key cryptography and its relation to graph theory
Enes Pasalic, *University of Primorska, Slovenia*
Some topics in the theory of finite groups
Primož Moravec, *University of Ljubljana, Slovenia*

Scientific Committee:
Klavdija Kutnar, Aleksander Malnič, Dragan Marušič, Štefko Miklavič, Primož Šparl

Organizing Committee:
Iva Antončič, Ademir Hujdurović, Boštjan Frelih, Boštjan Kuzman (head)

Sponsored by:
ARRS *(Slovenian Research Agency)*.
MIZŠ RS *(Ministry of Education, Science and Sport)*.
ESF EuroGIGA GReGAS *(European Science Foundation, Graphs in Geometry and Algorithms, Geometric representations and symmetries of graphs, maps and other discrete structures and applications in science)*.

Website: http://www.famnit.upr.si/en/conferences/
Email: sygn@upr.si

SYGN IV TIMETABLE

Note that the timetable is subject to change. The final version will be available on the conference website.

Sunday, June 29

17:00 - 19:00 *Registration*
20.00 - 20:15 *Opening Remarks*

Monday, June 30

09:00 – 09:30 S. Wilson: *Semisymmetric Graphs from Algebraic LR Structures ...*
09:30 – 10:00 I. Hubard: *Realizations of* $\{4,4\}$ *Toroidal Maps*
10:15 – 13:00 *SYGN Workshop*
14:00 – 16:45 *SYGN Workshop*

Tuesday, July 1

09:00 – 09:30 E. Schulte: *Skeletal Polyhedra, Polygonal Complexes, and Nets*
09:30 – 10:00 L. Martinez Fernandez: *On the Number of Words ...*
10:15 – 13:00 *SYGN Workshop*
14:00 – 16:45 *SYGN Workshop*
19:00 – 23:00 *Conference Photo and Dinner at Jurgovo*

Wednesday, July 2

09:00 – 10:30 *Free discussion*
11:00 – 11:30 P. Terwilliger: *Billiard Arrays and Finite-dimensional ...*
11:30 – 12:00 S. F. Du: *A Classification of Regular Embeddings of ...*
12:00 – 12:30 Y. S. Kwon: *Classification of Reflexible Edge-transitive Embeddings ...*
12:30 – 13:00 Y. Q. Feng: *Pentavalent Symmetric Graphs of Order Twice ...*
14:00 – 18:30 L. Simčić, A. Medvedev, K. Stokes, A. Švob, X. Ma, W. Xu, J. Zhang, G. Pretel, A. G. Lynch, I. Estélyi: *Contributed talks*

Thursday, July 3

09:00 – 09:30 T. Szönyi: *On Colorings of Projective Planes and Spaces*
09:30 – 10:00 M. D. E. Conder: *Skew Morphisms of Finite Groups*
10:15 – 13:00 *SYGN Workshop*
14:00 – 16:45 *SYGN Workshop*

Friday, July 4

09:00 – 09:30 M. Giudici: *Graph-restrictive Permutation Groups and the PSV ...*
09:30 – 10:00 G. Kiss: *Colorings of Affine and Projective Spaces*
10:15 – 13:00 *SYGN Workshop*
14:00 – 16:45 *SYGN Workshop*
16:45 – 17:00 *Closing Remarks*

PhD Summer School Timetable

Note that the timetable is subject to change. The final version will be available on the conference website.

Sunday, June 29
17:00 - 19:00 *Registration*
20.00 - 20:15 *Opening Remarks*
20.15 - 21:00 D. Witte Morris: *On Hamiltonian Cycles in Cayley Graphs with ...*

Monday, June 30
09:00 – 10:00 *Warm up Problems*
10:15 – 13:00 M. Ellingham: *Construction Techniques for Graph Embeddings* (1)
14:00 – 16:45 E. Pasalic: *Symmetric Key Cryptography and Graph Theory* (1)
17:00 – 19:00 S. Bajrić: *Cryptography Tutorial*

Tuesday, July 1
09:00 – 10:00 *Warm up Problems*
10:15 – 13:00 M. Ellingham: *Construction Techniques for Graph Embeddings* (2)
14:00 – 16:45 E. Pasalic: *Symmetric Key Cryptography and Graph Theory* (2)
17:00 – 19:00 S. Bajrić: *PhD Defense*
19:00 – *Conference Photo and Dinner at Jurgovo*

Wednesday, July 2
09:00 – 10:00 *Warm up Problems*
10:15 – 11:00 J. Morris: *Automorphisms of Cayley Graphs that Respect Partitions*
11:00 – 13:00 *Problem Solving Workshop*
14:00 – 16:45 *Problem Solving Workshop*

Thursday, July 3
09:00 – 10:00 *Warm up Problems*
10:15 – 13:00 M. Meszka: *Combinatorial Designs* (1)
14:00 – 16:45 P. Moravec: *Some Topics in the Theory of Finite Groups* (1)

Friday, July 4
09:00 – 10:00 *Warm up Problems*
10:15 – 13:00 M. Meszka: *Combinatorial Designs* (2)
14:00 – 16:45 P. Moravec: *Some Topics in the Theory of Finite Groups* (2)
16:45 – 17:00 *Closing Remarks*

INVITED TALKS

Skew morphisms of finite groups

Marston Conder
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A skew morphism of a group is a variant of an automorphism, which arises in the study of regular Cayley maps (regular embeddings of Cayley graphs on surfaces, with the property that the ambient group induces a vertex-regular group of automorphisms of the embedding). More generally, skew morphisms arise in the context of any group expressible as a product AB of subgroups A and B with B cyclic and $A \cap B = \{1\}$. Specifically, a skew morphism of a group A is a bijection $\varphi : A \to A$ fixing the identity element of A and having the property that $\varphi(xy) = \varphi(x)\varphi^{\pi(x)}(y)$ for all $x, y \in A$, where $\pi(x)$ depends only on x. The kernel of φ is the subgroup of all $x \in A$ for which $\pi(x) = 1$. In this talk I will present some of the theory of skew morphisms, including some very new theorems: two about the order and kernel of a skew morphism of a finite group, and a complete determination of the finite abelian groups for which every skew morphism is an automorphism.

A classification of regular embeddings of graphs of order prime-cube

Shaofei Du
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A 2-cell embedding of a graph into an orientable or nonorientable closed surface is called regular if its automorphism group acts regularly on its arcs and flags respectively. One of central problems in topological graph theory is to classify regular maps by given underlying graphs or automorphism groups. In this talk, we shall introduce a classification of the regular embeddings of arc-transitive simple graphs of order p^3 for any prime p into orientable surfaces.

Joint work with Miss Y.H. Zhu and Doc X. S. Ma.

Pentavalent symmetric graphs of order twice a prime power

Yan Quan Feng
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A graph is symmetric if its automorphism group acts transitively on ordered adjacent pairs of vertices of the graph. Let p be a prime and let $n \geq 2$ be a positive integer. In this talk, symmetric Z_p^n-covers of the dipole Dip_5 (the graph with two vertices connected by five multiple edges) are classified and their full automorphism groups are determined. Among others, connected pentavalent symmetric graphs of order $2p^2$ and $2p^3$ are classified.

This is a joint work with Yan-Tao Li, Da-Wei Yang and Jin-Xin Zhou.

Graph-restrictive permutation groups and the PSV Conjecture

Michael Giudici
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A permutation group L of degree d is called graph-restrictive if there is a constant c such that for every connected graph Γ of valency d admitting a group of automorphisms G with local action $G_v^{\Gamma(v)} \cong L$ we have that $|G_v| \leq c$. Using this terminology, the Weiss Conjecture asserts that every primitive group is graph-restrictive. Potočnik, Spiga and Verret have proved that if a group is graph-restrictive then it must be semiprimitive and conjectured that the converse also holds. In this talk I will discuss recent progress in collaboration with Luke Morgan on this conjecture, where we prove that the conjecture is true for a wide class of semiprimitive groups.

Realizations of $\{4,4\}$ toroidal maps

Isabel Hubard
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There are five symmetry types of maps on the torus of type $\{4,4\}$. After revisiting all families of all five symmetry types, we shall show that if every regular toroid of type $\{4,4\}$ admits a realisation on a metric space S, then every toroid of type $\{4,4\}$ admits a realisation on S.

Colorings of affine and projective spaces

György Kiss
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There are sevaral variations of vertex and edge colorings of hypergraphs.

A *vertex coloring* of a hypergraph $\mathscr{H} = (X, \mathscr{C})$ is a mapping ϕ from X to a set of colors $\{1,2,\ldots,k\}$. A *strict rainbow-free k-coloring* is a mapping $\phi : X \to \{1,\ldots,k\}$ that uses each of the k colors on at least one vertex such that each edge of $\mathscr{H}$ has at least two vertices with the same color. If $X_i = \phi^{-1}(i)$, then a different but equivalent view is a *color partition* $X_1 \cup cdots \cup X_k = X$ with k nonempty classes. A coloring is called *balanced,* if $-1 \leq |X_i| - |X_j| \leq 1$ holds for all $i \neq j$.

An *edge coloring* of $\mathscr{H}$ with k colors is a surjective function that assigns to edges of $\mathscr{H}$ a color from a k-set of colors. An edge coloring with k colors is *proper,* if for all intersecting pairs of edges have different colors. The *chromatic index* $\chi'(\mathscr{H})$ is the smallest number k for which there exists a proper coloring of $\mathscr{H}$ with k colors. A coloring with k colors is *complete* if each pair of colors appears on at least one vertex of $\mathscr{H}$. The *pseudoachromatic index* $\psi'(\mathscr{H})$ is the largest number k for which there exist a complete coloring with k colors, while the *achromatic index* $\alpha'(\mathscr{H})$ is the largest number k for which there exist a proper and complete coloring with k colors.

Let Π be an n-dimensional finite affine or projective space and $0 < d < n$ be an integer. Then Π may be considered as a hypergraph, whose vertices and hyperedges are the points and the d-dimensional subspaces of the space, respectively.

In this talk we survey the known results and give new estimates on the coloring indices of affine and projective spaces and present some new rainbow-free vertex colorings of projective spaces.

Classification of reflexible edge-transitive embeddings of $K_{m,n}$ and corresponding groups

Young Soo Kwon
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In this talk, we classify reflexible edge-transitive embeddings of complete bipartite graphs by partite set preserving automorphisms. As a by-product, we classify groups Γ such that (i) $\Gamma = XY$ for some cyclic groups $X = \langle x \rangle$ and $Y = \langle y \rangle$ with $X \cap Y = \{1_\Gamma\}$ and (ii) there exists an automorphism of Γ which sends x and y to x^{-1} and y^{-1}, respectively.

On the number of words of a given GC-content in some cyclic DNA-codes

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DNA-codes are codes over an alphabet of four letters, corresponding to the four nucleotides Adenine (A), Thymine (T), Guanine (G) and Cytosine (C), which are often represented using the elements of the field $\mathbb{F}_4$ or of the ring $\mathbb{Z}/4\mathbb{Z}$. DNA-codes have found numerous applications in biotechnology; for example, they have been used as molecular barcodes in chemical libraries, or for biomolecular computation. Usually, several combinatorial restrictions are imposed to guarantee that the melting temperature of the DNA-sequences modelled by the words in the code is similar. One of these conditions asks for the GC-content to be constant, which means that the number of symbols G or C is the same for all words in the code. For a variety of cyclic DNA-codes, we find the number of words of a given GC-content. We give also a survey of some topics in the theory of DNA-codes.

This is a joint work with Josu Sangroniz.

Automorphisms of Cayley graphs that respect partitions

Joy Morris
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A Cayley graph $\Gamma = \mathrm{Cay}(G;S)$ on a group G with connection set S, is a graph whose vertices are labelled with the elements of G, with vertices g_1 and g_2 adjacent if $g_1^{-1}g_2 \in S$. We say that an automorphism α of Γ respects the partition $\mathscr{C}$ of the edge set of Γ if for every $C \in \mathscr{C}$, we have $\alpha(C) \in \mathscr{C}$. I will discuss some obvious partitions of the edge set of a Cayley graph Γ, and find conditions under which a graph automorphism of Γ that respects these partitions and fixes a vertex, must be an automorphism of the group G.

Billiard Arrays and finite-dimensional irreducible $U_q(\mathfrak{sl}_2)$-modules

Paul Terwilliger
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In this talk we will describe the notion of a Billiard Array. This is a triangular array of one-dimensional subspaces of a finite-dimensional vector space, subject to several conditions that specify which sums are direct. We use Billiard Arrays to characterize the finite-dimensional irreducible $U_q(\mathfrak{sl}_2)$-modules, for q not a root of unity. The equitable presentation of $U_q(\mathfrak{sl}_2)$ comes up naturally in this context.

Skeletal Polyhedra, Polygonal Complexes, and Nets

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Skeletal polyhedra and polygonal complexes in 3-space are finite, or infinite periodic, geometric edge graphs equipped with additional polyhedra-like structure determined by faces (simply closed planar or skew polygons, zig-zag polygons, or helical polygons). The edge graphs of the infinite polyhedra and complexes are periodic nets. We discuss classification results for skeletal polyhedra and polygonal complexes in 3-space by distinguished transitivity properties of the symmetry group, as well as the relevance of these structures for the classification of crystal nets.

On colourings of projective planes and spaces

Tamás Szönyi
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The chromatic number of a hypergraph is the smallest number of colours needed to colour the points so that no edge is monochromatic. Projective planes of order greater than 2 have chromatic number 2, which simply means that projective planes of order greater than 2 have non-trivial blocking sets.

We shall be more interested in the upper chromatic number of projective planes and spaces. The notion comes from Voloshin's work on colourings of mixed hypergraphs. For a hypergraph, the upper chromatic number denotes the maximum number of colours in a colouring of the points such that each edge has at least two points of the same colour. So, instead of excluding monochromatic edges we exclude "rainbow" ones. Edges of our hypergraph are lines or subspaces of fixed dimension. Few results are known for general planes, mainly due to Bacsó and Tuza. In the talk we focus on determining or bounding the upper chromatic number of planes and spaces over finite fields. The following construction relates the upper chromatic number and the minimum size of a double blocking set. A double blocking set is a set of points that intersects each line (or subspace of given dimension in case of projective spaces). Take a double blocking set and colour all of its points red. The remaining points get pairwise different colours. This trivial colouring gives a lower bound ont he upper chromatic number. In several cases we could prove that we actually have equality in the bound coming from the above trivial colouring and sometimes can even show a stability results for the trivial colouring.

Joint work with Gábor Bacsó, Tamás Héger.

Semisymmetric graphs from algebraic LR Structures: Large vertex stabilizers

Steve Wilson
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LR structures are cycle decompositions of tetravalent graphs having two orbits of edges and satisfying some transitivity and flexibility conditions. We construct tetravalent semisymmetric graphs of girth 4 from them, using the partial line graph. This talk will show some general constructions of LR structures from groups of several kinds. We then show LR structures related to dihedral groups which have arbitrarily large vertex stabilizers. The large-stabilizers phenomenon is now better understood in the dart-transitive case due to work by Potočnik, Verret and Spiga. It is less-well understood in the semisymmetric case, and these examples will help us to increase that understanding.

This is joint work with Primož Potočnik.

On hamiltonian cycles in Cayley graphs with commutator subgroup of order pq

Dave Witte Morris
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More than 30 years ago, Erich Durnberger used methods of D. Marušič to prove that if the commutator subgroup of G has prime order p, then every connected Cayley graph on G has a hamiltonian cycle. Marušič suggested that it should be possible to replace the prime p with the product of two distinct primes p and q, but this seems to be a much more difficult problem. We will describe the current status of this project, which has been completed when G is either nilpotent or of odd order. The nilpotent case is joint work with E. Ghaderpour.

CONTRIBUTED TALKS

On groups all of whose undirected Cayley graphs of bounded valency are integral

István Estélyi
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A finite group G is called Cayley integral if all undirected Cayley graphs over G are integral, i.e., all eigenvalues of the graphs are integers. The Cayley integral groups have been determined by Klotz and Sander [1] in the abelian case, and by Abdollahi and Jazaeri [2], and independently by Ahmady, Bell and Mohar [3] in the non-abelian case. In this talk we will generalize this class of groups by introducing the class $\mathscr{G}_k$ of finite groups G for which all graphs $\mathrm{Cay}(G,S)$ are integral if $|S| \leq k$. It will be proved that $\mathscr{G}_k$ consists of the Cayley integral groups if $k \geq 6$; and the classes $\mathscr{G}_4$ and $\mathscr{G}_5$ are equal, and consist of: (1) the Cayley integral groups, (2) the generalized dicyclic groups $\mathrm{Dic}(E_{3^n} \times \mathbb{Z}_6)$, where $n \geq 1$.

[1] W. Klotz, T. Sander, Integral Cayley graphs over abelian groups, *Electronic J. Combin.* **17** (2010), #R81.

[2] A. Abdollahi, M. Jazaeri, Groups all of whose undirected Cayley graphs are integral *Europ. J. Combin.* **38** (2014), 102–109.

[3] A. Ahmady, J. P. Bell, B. Mohar, Integral Cayley graphs and groups, preprint arXiv: 1209.5126v1 [math.CO] 2013.

[4] I. Estélyi, I. Kovács, On groups all of whose undirected Cayley graphs of bounded valency are integral, preprint arXiv:1403.7602 [math.GR] 2014.

Finite-dimensional irreducible modules for an even subalgebra of $U_q(\mathfrak{sl}_2)$

Alison Gordon Lynch
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The quantum algebra $U_q(\mathfrak{sl}_2)$ has connections to Q-polyonomial distance-regular graphs, tridiagonal pairs of linear transformations, the q-tetrahedron algebra, as well as many other combinatorial and algebraic objects. In 2006, Ito, Terwilliger, and Weng gave a presentation for $U_q(\mathfrak{sl}_2)$ in generators x, y, y^{-1}, z, called the *equitable presentation*, and showed that $\{x^r y^s z^t : r, t \in \mathbb{N}, s \in \mathbb{Z}\}$ is a basis for $U_q(\mathfrak{sl}_2)$. In 2013, Bockting-Conrad and Terwilliger introduced a subalgebra $\mathscr{A}$ of $U_q(\mathfrak{sl}_2)$ spanned by the elements $\{x^r y^s z^t : r, s, t \in \mathbb{N}, r+s+t \text{ even}\}$. In this talk, we give a presentation for the algebra $\mathscr{A}$ and we show that for every $d \geq 1$, there exists a unique irreducible $\mathscr{A}$-module of dimension d.

The Classification of Minimal non-core-2 2-groups with Almost Maximal Class

Xuesong Ma
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Let G be a finite group with order 2^n. G is called core-2 group if $|H : H_G| \leq 2$ for all subgroup $H \leq G$. In this paper, we classified the minimal non-core-2 2-groups with almost maximal class.

Joint work with Jiyong Chen, Shaofei Du, Jing Xu and Mingyao Xu.

Prefix-reversal Gray codes

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Two scenarios are known to get prefix-reversal Gray codes. The first one was given by S. Zaks in 1984 [BIT, 24, 196-204], and the second one was suggested by A. Williams and J. Sawada in 2013 [Electronic Notes in Discrete Math., 44, 357-362]. In this talk we consider other approaches for obtaining prefix-reversal Gray codes. It was noticed that both constructions are based on the independent small even cycles in the Pancake graph. We provide the series of these cycles and study the existence of prefix-reversal Gray codes on them.

Compatible elements for a tridiagonal pair

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Roughly speaking, tridiagonal pairs of Krawtchouk type correspond to the finite-dimensional irreducible modules of a certain Lie algebra known as the Onsager algebra. E. Date and S. S. Roan showed that the Onsager algebra is embedded in another Lie algebra known as the $\mathfrak{sl}_2$ loop algebra. They classified the finite-dimensional irreducible modules for the Onsager algebra, and in particular they showed that every such module is obtained from an $\mathfrak{sl}_2$ loop algebra module by restriction. It is then natural to consider the various ways of extending a given Onsager algebra module to an $\mathfrak{sl}_2$ loop algebra module. We consider these extensions and how they are related to one another. To aid in this description we introduce the notion of a compatible element for a tridiagonal pair. We discuss a case in which these extensions have a simple combinatorial interpretation in terms of hypercubes.

Codes constructed from orbit matrices of block designs

Loredana Simčić
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In this talk we will describe under which conditions the orbit matrix of a block design under the action of automorphism group generates a self-orthogonal code. The obtained results are the generalization of the construction method of self-orthogonal codes from orbit matrices of block designs under the action of an automorphism group of prime order with no fixed points and blocks, given by Harada and Tonchev.

Joint work with Dean Crnković.

Irreducibility of configurations

Klara Stokes
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In a paper from 1886, Martinetti enumerated small v_3-configurations using a construction that permits to produce a $(v+1)_3$-configuration from a v_3-configuration. He called configurations that were not constructible in this way irreducible configurations. According to his definition, the irreducible configurations are Pappus' configuration and four infinite families of configurations. In 2005, Boben defined a simpler and more general definition of irreducibility, for which only two v_3-configurations, the Fano plane and Pappus' configuration, remained irreducible. In this talk I describe how to generalize this construction to both balanced and unbalanced (v,b,r,k)-configurations and I give some general results on augmentability and reducibility.

Transitive combinatorial structures constructed from finite groups

Andrea Švob
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The main subject of the talk is the construction of transitive combinatorial structures from finite groups. The method will be applied on the construction of 2-designs and strongly regular graphs. The structures will be defined on the conjugacy classes of the maximal and second maximal subgroups under the action of finite groups or their maximal subgroups. Constructed structures and their automorphism groups will be described.

This is a joint work with Dean Crnković and Vedrana Mikulić Crnković.

2-Arc-Transitive Metacyclic Covers of Complete Graphs

Wenqin Xu
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Regular covers of complete graphs whose fibre-preserving automorphism groups act 2-arc-transitively are investigated. Such covers have been classified when the covering transformation groups K are cyclic groups $\mathbb{Z}_d$ for an integer $d \geq 2$, metacyclic abelian groups $\mathbb{Z}_p^2$, or nonmetacyclic abelian groups $\mathbb{Z}_p^3$ for a prime p (see S.F. Du, D. Marušič and A.O. Waller, On 2-arc-transitive covers of complete graphs, J. Comb. Theory, Ser. B, 74(1998), 276–290 for the first two metacyclic group cases and see S.F. Du, J.H. Kwak and M.Y. Xu, On 2-arc-transitive covers of complete graphs with covering transformation group $\mathbb{Z}_p^3$, J. Combin. Theory, B 93 (2005), 73–93 for the third nonmetacyclic group case.) In this talk, we shall introduce a complete classification of all such covers when K is a metacyclic group.

Joint work with S.F. Du, J.H. Kwak and M.Y. Xu.

Vertex-Transitive Digraphs of Order p^5 are Hamiltonian

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It is proved that connected vertex-transitive digraphs of order p^5 (where p is a prime) are Hamiltonian, and a connected digraph whose automorphism group contains a finite vertex-transitive subgroup G of prime power order such that G' is generated by two elements or elementary abelian is Hamiltonian.

MINICOURSE DESCRIPTIONS

Construction techniques for graph embeddings

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Mathematicians have been trying to construct embeddings of specific graphs in surfaces since at least the 1890s. However, until the 1960s the construction techniques were usually fairly ad hoc, although some general ideas such as 'schemes of cyclic sequences' had emerged. This changed with the development of current graphs by Gustin and others in the 1960s, which provided a unified framework for many earlier constructions and played an important role in the proof of the Map Colour Theorem. Fifty years later we have a number of useful general tools for constructing embeddings of graphs. These lectures will survey tools of various kinds. We will look at algebraic methods such as current, voltage and transition graphs; surgical tools such as the diamond sum and adding handles or crosscaps around a vertex; lifting constructions due to Bouchet and his collaborators; and techniques that use objects from design theory, such as latin squares, to construct embeddings.

Combinatorial designs

Mariusz Meszka
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Combinatorial design theory rapidly developed in the second half of the twentieth century to an independent branch of combinatorics. It has deep interactions with graph theory, algebra, geometry and number theory, together with a wide range of applications in many other disciplines. Most of the problems are simple enough to explain even to non-mathematicians, yet the solutions usually involve innovative techniques as well as advanced tools and methods of other areas of mathematics. The most fundamental problems still remain unsolved.

This series of lectures is intended to provide a solid introduction to the major topics and concepts: block designs, Latin squares, difference sets, Hadamard matrices, Room squares, resolvable designs. Basic methods, constructions, results and open research problems will be followed by various examples and exercises.

Symmetric key cryptography and its relation to graph theory

Enes Pasalic
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Modern cryptology relies on many scientific disciplines such as information theory, probability theory, discrete mathematics among others. In addition, many public cryptosystems are based on some hard graph theoretic problems such as graph coloring for instance. While not directly derived from the concepts related to graphs, the most important cryptographic properties of certain discrete structures may be defined and analyzed in the graph theoretic framework which might give at least different insight at these structures. We will give a short survey of cryptography with the emphasis on these discrete structures being basic primitives in the so-called symmetric key cryptography. Booolean functions, vectorial mappings over finite structures and permutations over finite fields, as the most important representatives of these structures, will be considered in real-life encryption schemes. Their cryptographic properties will be stated both in a classical way using some suitable tools in cryptology and these will be then translated in the graph theoretic language. The students will also get a brief insight in the state-of-the-art research in this direction.

Some topics in the theory of finite groups

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The theory of finite groups plays a central role in group theory and has several applications in other branches of mathematics, including discrete mathematics and cryptography. The theory culminated with the classification of finite simple groups in 1983, and has developed afterwards into several different directions such as the theory of groups of prime power order, invariant theory, and many others.

This mini course will address some topics of the above theory. These will include advanced applications of Sylow's theory, techniques of building new groups from old, basic theory of finite p-groups, and problems regarding enumeration of finite groups.

A FEW WORDS ABOUT THE UNIVERSITY OF PRIMORSKA

Established in 2003, the University of Primorska (UP) is the youngest of the three state universities in Slovenia. It consists of seven Faculties: Faculty of Mathematics, Natural Sciences, and Information Technologies (UP FAMNIT), Faculty of Built Environment, Faculty of Education, Faculty of Humanities, Faculty of Management, Faculty of Tourism, and Faculty of Health Sciences; and two research institutes, the Andrej Marušič Institute (UP IAM), and the Science and Research Centre.

With their international faculty and many research links all over the world, UP FAMNIT and its research counterpart UP IAM are at the forefront of the academic development of UP. Student enrollment at UP FAMNIT has grown from approximately 100 in its first academic year (2007/08), to 776 in the academic year (2013/14).

UP FAMNIT offers BSc, MSc and PhD Degree programs in Mathematics, while faculty members carry out their research at UP IAM. Thus far, collaboration between UP FAMNIT and UP IAM has resulted in the following Graph Theory conferences and meetings:

- AC^2 – Algebraic Combinatorics on the Adriatic Coast, Koper, 2003, 2004, 2008, 2009.
- CoCoMat – Korea - Slovenia International Conference On Combinatorial and Computational Mathematics, Koper, 2007.
- SYGN - International Workshop on Symmetries of Graphs and Networks, 2010, 2012.
- PhD Summer Schools in Algebraic Graph Theory 2011 and Discrete Mathematics 2012, 2013.
- 7th Slovenian International Conference on Graph Theory, Bled, 2011.
- Graph Theory Semester, Koper, 2012.
- Computers in Scientific Discovery 6, 2012.
- Algebraic and Topological Aspects of Graph Covers, 2013.
- $DM = 60$ – Conference on Graph Theory and Combinatorics, 2013.
- CSASC – Joint Conference of Catalan, Slovak, Austrian, Slovenian and Checzh Mathematical Society, 2013.

Visit `www.famnit.upr.si` for more information on UP FAMNIT's graduate programs in mathematics and related fields. Visit `www.iam.upr.si` for more information on research.

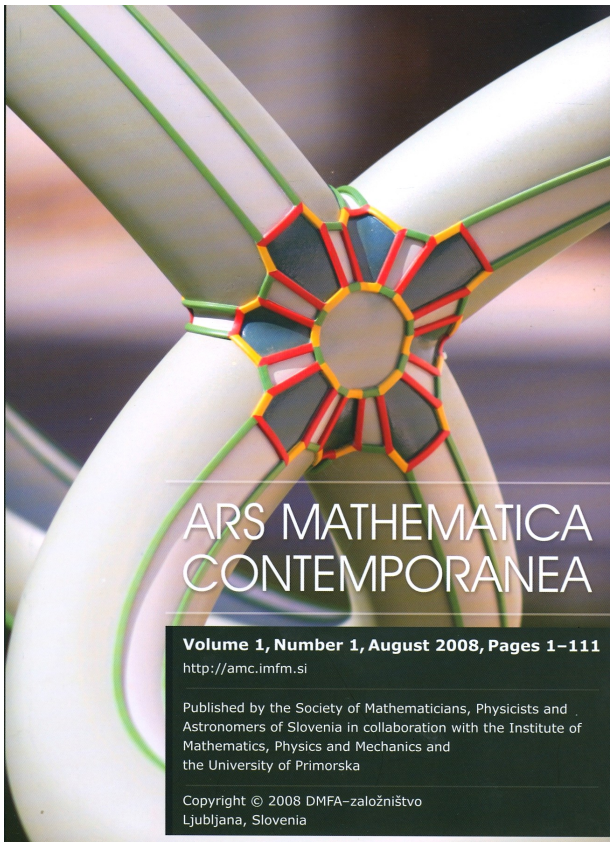
ARS MATHEMATICA CONTEMPORANEA

*A*rs Mathematica Contemporanea (AMC) is an international journal, published by UP in collaboration with IMFM and the Slovenian Society of Mathematicians, Physicists and Astronomers. The Founding Editors and Editors-in-Chief of AMC are Dragan Marušič and Tomaž Pisanski and its Editorial Board includes a number of internationally recognized mathematicians and affiliations.

The aim of AMC is to publish peer-reviewed high-quality articles in contemporary mathematics that arise from the discrete and concrete mathematics paradigm. It favors themes that combine at least two different fields of mathematics. In particular, papers intersecting discrete mathematics with other branches of mathematics, such as algebra, geometry, topology, theoretical computer science, and combinatorics, are most welcome.

For more information on submissions, please refer to the AMC website

`http://amc-journal.eu`.



UPCOMING EVENTS

- Ljubljana-Leoben Graph Theory Seminar, Koper, September 3-5, 2014.
- Algorithmic Graph Theory on the Adriatic Coast, Koper, June 16-19, 2015.
- 8th Slovenian International Conference on Graph Theory, Kranjska gora, June 21-27, 2015 (a.k.a. the Bled conference).

See `http://www.famnit.upr.si/en/conferences/` for more information.

Symmetries of Graphs and Networks IV and 2014 PhD Summer School in Discrete Mathematics.
Rogla, Slovenia, 29 June – 5 July 2014.

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