Program (Day 1 – May 21 (Sat.))

Plenary Talk: Centennial Memorial Hall (1F)
Contributed Talk:
a) Centennial Memorial Hall (1F) b) International Conference Hall I (2F)
c) International Conference Hall II (2F) d) International Conference Hall III (2F)
Registration/Information Desk: in front of International Conference Hall II (2F, 12:00–18:00)
Coffee Break: Conference Room III, IV (2F)

13:20

Opening Remarks at Centennial Memorial Hall (1F)

13:30

Bush-type Hadamard matrices and applications
Hadi Kharaghani (University of Lethbridge, Canada)

14:30

Coffee Break

15:00

a) *Hereditary properties of simplicial complexes and h-triangles*
Masahiro Hachimori (University of Tsukuba, Japan)

b) *Neighbour distinguishing graph colourings*
Jakub Przybyło (AGH University of Science and Technology, Poland)

c) *On SD-prime Labeling of Graphs*
Gee-Choon Lau (MARA University of Technology, Malaysia)

d) *Double-weighted Paired-domination on Graphs*
Yi-Hua Yang (National Tsing Hua University, Taiwan)

15:20

15:25

a) *Multibasic Ehrhart theory*
Aki Mori (Osaka University, Japan)

b) *On directed versions of 1-2-3 Conjecture*
Mariusz Woźniak (AGH University, Poland)

c) *On Super (a, d)-star-antimagic total labeling of generalized Petersen graph*
Mania Roswitha (Sebelas Maret University, Indonesia)

d) *Total domination and the annihilation number of a graph - on a conjecture of Graffiti.pc*
Christoph Brause (TU Bergakademie Freiberg, Germany and University of Johannesburg, South Africa)

15:45

15:50

a) *Optimal Arrangements in Euclidean Space*
Zongchen Chen (Shanghai Jiao Tong University, China)

b) *On total weight choosability of graphs*
Tsai-Lien Wong (National Sun Yat-sen University, Taiwan)

c) *Cycle-Supermagic Covering on Sunflower Graph*
Titin Sri Martini (Sebelas Maret University, Indonesia)

d) *On locating-dominating number of circulant graphs*
Suhadi Wido Saputro (Institut Teknologi Bandung, Indonesia)

16:10

16:15

a) *1-well-covered graphs and partial unimodality of independence polynomials*
Eugen Mandrescu (Holon Institute of Technology, Israel)

b) *Bipartite polyhedral maps are disinguishing 3-colorable with few exceptions*
Seiya Negami (Yokohama National University, Japan)

c) *On the edge irregularity strength of corona product of graphs with cycle*
Roslan Hasni (Universiti Malaysia Terengganu (UMT), Malaysia)

d) *Results on expansion of global secure sets*
Hsin-Hao Lai (National Kaohsiung Normal University, Taiwan)

16:35

Coffee Break

17:00

Symmetric, unimodal and gamma-nonnegative polynomials in combinatorics and geometry
Christos Athanasiadis (University of Athens, Greece)

18:00

18:15

Welcome Reception

20:15

Program (Day 2 – May 22 (Sun.))

Plenary Talk: Centennial Memorial Hall (1F)
Contributed talk and Mini Symposium:
a) Centennial Memorial Hall (1F) b) International Conference Hall I (2F)
c) International Conference Hall II (2F) d) International Conference Hall III (2F)
Registration/Information Desk: in front of International Conference Hall II (2F, 9:10–18:10)
Coffee Break: Conference Room III, IV (2F)

9:40

Smith normal form and combinatorics
Richard P. Stanley (Massachusetts Institute of Technology, USA)

10:40

Coffee Break

11:00

a) *On 2-factors through specified perfect matchings in bipartite graphs*
Shuya Chiba (Kumamoto University, Japan)

b) *Some conditions on $G[V_5(G)]$ for a 5-connected graph G to have a contractible edge*
Kiyoshi Ando (National Institute of Informatics, JST ERATO Kawarabayashi Large Graph Project, Japan)

c) *Graph parameters from symplectic group invariants*
Bart Sevenster (University of Amsterdam, the Netherlands)

d) *Tiling of the Sphere by Almost Equilateral Pentagons*
Min Yan (Hong Kong University of Science and Technology, Hong Kong)

11:20

11:25

a) *Connected even factors in the square of 2-edge connected graphs*
Jan Ekstein (University of West Bohemia, Czech Republic)

b) *A heuristic approach to dividing graphs into bi-connected components of specified size*
Raka Jovanovic (Hamad bin Khalifa University, Qatar)

c) *On the chromatic number of zero-divisor graphs of modules*
Rezvan Varmazyar (Islamic Azad University, Iran)

d) *Learning a hidden uniform hypergraph*
Huilan Chang (National University of Kaohsiung, Taiwan, ROC)

11:45

11:50

a) *On s-hamiltonian line graphs of claw-free graphs*
Mingquan Zhan (Millersville University of Pennsylvania, USA)

b) *Highly connected subgraphs in sparse graphs*
Henry Liu (Central South University, China)

c) *Travel groupoids and combinatorial structures on a graph*
Yoshio Sano (University of Tsukuba, Japan)

d) *A variant of hypercube with small diameter*
Xuding Zhu (Zhejiang Normal University, China)

12:10

Lunch

13:40

Hamilton cycles in line graphs
Tomáš Kaiser (University of West Bohemia, Czech Republic)

14:40

Coffee Break

15:00

b) Mini Symposium : Enumerative Combinatorics
(Organizers: Yasuhide Numata and Soichi Okada)

15:00-15:30 *Ehrhart polynomials of lattice simplices and linear binary code*
Akihiro Higashitani (Kyoto Sangyo University, Japan)

15:45-16:15 *On q-integrals over order polytopes*
Jang Soo Kim (Sungkyunkwan University, Korea)

16:30-17:00 *Triple product formulae for boxed plane partitions derived from orthogonal polynomials*
Shuhei Kamioka (Kyoto University, Japan)

17:15-17:45 *Evacuation and cyclic sieving on partitions*
Sen-Peng Eu (National Taiwan Normal University & Chinese Air Force Academy, Taiwan)

d) Mini Symposium : Spectral Graph Theory and Related Topics
(Organizers: Yoshio Sano, Hajime Tanaka and Tetsuji Taniguchi)

15:00-15:50 *Association schemes and almost distance-regular graphs*
Edwin van Dam (Tilburg University, the Netherlands)

16:00-16:20 *Strongly regular graphs with the same parameters as the symplectic graph*
Sho Kubota (Tohoku University, Japan)

16:20-16:40 *On equiangular lines and regular graphs*
Gary Greaves (Tohoku University, Japan)

16:40-17:00 *On a lower bound on the Laplacian eigenvalues of a graph*
Akihiro Munemasa (Tohoku University, Japan)

17:10-17:30 *A generalization of a Hoffman's theorem*
Jae young Yang (POSTECH, South Korea)

17:30-17:50 *Spectral and stochastic behaviors of Grover walks*
Etsuo Segawa (Tohoku University, Japan)

17:50-18:10 *Multi-way expanders and imprimitive group actions on graphs*
Masato Mimura (Tohoku University, Japan)

Program (Day 3 – May 23 (Mon.))

Plenary Talk: Centennial Memorial Hall (1F)
Contributed Talk:
a) Centennial Memorial Hall (1F) b) International Conference Hall I (2F)
c) International Conference Hall II (2F) d) International Conference Hall III (2F)
Registration/Information Desk: in front of International Conference Hall II (2F, 9:10–12:10)
Coffee Break: Conference Room III, IV (2F)

9:40

Coloring some perfect graphs
Maria Chudnovsky (Princeton University, USA)

10:40

Coffee Break

11:00

a) *A new approach to the four color theorem via associahedra*
Yuhei Inoue (Tohoku University, Japan)

b) *Lattice simplices having small degrees*
Akihiro Higashitani (Kyoto Sangyo University, Japan)

c) *Critical groups of strongly regular graphs*
Joshua E. Ducey (James Madison University, USA)

d) *A cluttered ordering for a bipartite graph*
Tomoko Adachi (Toho University, Japan)

11:20

11:25

a) *Kempe equivalence of 3-edge-colorings in cubic graphs on the projective plane*
Kenta Ozeki (National Institute of Informatics, JST ERATO Kawarabayashi Large Graph Project, Japan)

b) *FFLV Polytopes and Their Vertices*
Igor Makhlin (National Research University HSE, Russia)

c) *2-arc-transitive graphs of order 4p*
Mohsen Ghasemi (Urmia University, Iran)

d) *On a lower bound graph of a lattice*
Gen Kawatani (Yokohama National University, Japan)

11:45

11:50

a) *Z_3-connectivity of triangularly-connected graphs*
Ju Zhou (Kutztown University of Pennsylvania , USA)

b) *Volume of Gorenstein Fano polytopes arising from order polytopes and chain polytopes*
Akiyoshi Tsuchiya (Osaka University, Japan)

c) *Asymmetry of tournaments and some related results*
Shohei Satake (Nagoya University, Japan)

d) *A generalization of vertex rankings of graphs*
Jobby Jacob (Rochester Institute of Technology, U.S.A.)

12:10

Lunch and Excursion

19:00

Banquet at Kyoto Royal Hotel & Spa

21:30

Program (Day 4 – May 24 (Tue.))

Plenary Talk: Centennial Memorial Hall (1F)
Contributed talk and Mini Symposium:
a) Centennial Memorial Hall (1F) b) International Conference Hall I (2F)
c) International Conference Hall II (2F) d) International Conference Hall III (2F)
Registration/Information Desk: in front of International Conference Hall II (2F, 9:10–18:10)
Coffee Break: Conference Room III, IV (2F)

9:40

Crossing Roads in Combinatorial Optimization: The Salesman, The Postman and Polyhedra
András Sebő (CNRS, Laboratoire G-SCOP, Université Grenoble-Alpes, France)

10:40

Coffee Break

11:00

a) *Sum List Colorings of Graphs*
Arnfried Kemnitz (Technical University of Braunschweig, Germany)

b) *A new universal cycle for permutations*
Dennis Wong (Northwest Missouri State University, USA)

c) *Some existence of splitting BIB designs*
Kazuki Matsubara (Chuo Gakuin University, Japan)

d) *Signed Sum Free Sets*
Angelica Klosky (Gettysburg College, United States)

11:20

11:25

a) *On r-Equitable Coloring of Graph Products*
Chih-Hung Yen (National Chiayi University, Taiwan, R.O.C.)

b) *On the Maximal Matching Polytope*
Mustafa Kemal Tural (Middle East Technical University, Turkey)

c) *On symmetric BIBDs with the same 3-subset multiplicity*
Da Zhao (Shanghai Jiao Tong University, China)

d) *Refinement of the structure constants in the class-sum algebra of the symmetric group*
Jacob Katriel (Technion - Israel Institute of Technology, Israel)

11:45

11:50

a) *Maximal edge-colorings of graphs*
Mariusz Meszka (AGH University of Science and Technology, Poland)

b) *Approximation Algorithms for the Steiner Tree Problem with the Bounded Edge-length*
Chi-Yeh Chen (National Cheng Kung University, Taiwan, ROC)

c) *On the existence of* $S(3, \{4, 5, 7\}, v)$
Li Yun (Soochow University, China)

d) *Trees and Regularity of Binomial Edge Ideals*
Narayanan N (Indian Institute of Technology Madras, Indian)

12:10

Lunch

13:40

Uniform Mixing and Quantum Walks
Chris Godsil (University of Waterloo, Canada)

14:40

Coffee Break

15:00

b) Mini Symposium : Combinatorics of hyperplane arrangements
(Organizers: Takuro Abe and Masahiko Yoshinaga)

15:00-15:30 *Combinatorics of hyperplane arrangements: Open problems and recent progress*
Christos Athanasiadis (University of Athens, Greece)

15:30-16:00 *Linial arrangements and Eulerian polynomials*
Masahiko Yoshinaga (Hokkaido University, Japan)

16:15-16:45 *Valid orderings of a real hyperplane arrangement*
Richard P. Stanley (Massachusetts Institute of Technology, USA)

16:45-17:15 *A characterization of freeness for ψ-graphical arrangements*
Shuhei Tsujie (Hokkaido University, Japan)

17:30-18:00 *Divisional flags and freeness of hyperplane arrangements*
Takuro Abe (Kyushu University, Japan)

c) Mini Symposium : Hadamard matrices and combinatorial designs
(Organizers: Masakazu Jimbo, Masaaki Harada and Miwako Mishima)

15:00-15:50 *Revisiting certain symmetric designs and Hadamard difference sets*
Richard M. Wilson (California Institute of Technology, U.S.A.)

16:00-16:20 *Factorizations of cyclic groups and decompositions of a Singer orbit of a projective line*
Kohei Yamada (Nagoya University, Japan)

16:25-16:45 *On cyclic grid-block designs*
Xiao-Nan Lu (Nagoya University, Japan)

16:50-17:10 *Unbiased orthogonal designs*
Sho Suda (Aichi University of Education, Japan)

17:25-17:45 *On tight relative t-designs in hypercubes*
Hajime Tanaka (Tohoku University, Japan)

17:50-18:10 *New upper bounds for nonbinary codes based on quadruples*
Bart Litjens (University of Amsterdam, The Netherlands)

d) Mini Symposium : Discrete Convexity and Combinatorial Optimization
(Organizers: Shin-ichi Tanigawa and Kenjiro Takazawa)

15:00-15:30 *Network optimization on unit disk graphs*
Takuro Fukunaga (National Institute of Informatics, Japan)

15:30-16:00 *How to Make a Bipartite Graph DM-irreducible by Adding Edges*
Yutaro Yamaguchi (University of Tokyo, Japan)

16:10-16:40 *Maximizing Monotone Submodular Functions over the Integer Lattice*
Tasuku Soma (The University of Tokyo, Japan)

16:40-17:20 *Arborescence covering problems: structural results and algorithms*
Tamás Király (Eötvös University, Budapest, Hungary)

17:30-18:10 *Discrete Convex Analysis beyond $\mathbf{Z}^n$*
Hiroshi Hirai (The University of Tokyo, Japan)

Program (Day 5 – May 25 (Wed.))

Plenary Talk: Centennial Memorial Hall (1F)
Contributed Talk:
a) Centennial Memorial Hall (1F) b) International Conference Hall I (2F)
c) International Conference Hall II (2F) d) International Conference Hall III (2F)
Registration/Information Desk: in front of International Conference Hall II (2F, 9:10–16:10)
Coffee Break: Conference Room III, IV (2F)

9:40

Reconfiguring graph colourings
Gary MacGillivray (University of Victoria, Canada)

10:40

Coffee Break

11:00

a) *Codes from neighborhood designs of the graphs $GP(q, \frac{q-1}{2})$ with q odd*
Jirapha Limbupasiriporn (Silpakorn University, Thailand)

b) *On color-degree conditions for long rainbow paths*
Roman Čada (University of West Bohemia, Czech Republic)

c) *Chromatic number of P_5-free graphs: χ-binding functions*
Ingo Schiermeyer (Technische Universität Bergakademie Freiberg, Germany)

d) *On Weighing Matrices*
Giora Dula (Netanya Academic College, Israel)

11:20

11:25

a) *Combinatorial Constructions of Optimal $(m, n, 4, 2)$ Optical Orthogonal Signature Pattern Codes*
Jingyuan Chen (Soochow University, China)

b) *Forbidden subgraphs and weak locally connected graphs*
Liming Xiong (Beijing Institute of Technology, P.R. China)

c) *Domination number of outer annulus triangulations*
Toshiki Abe (Yokohama National University, Japan)

d) *Bounded growth functions: Gray codes and exhaustive generation*
Vincent Vajnovszki (LE2I, Université de Bourgogne Franche-Comté, France)

11:45

11:50

a) *On Terwilliger algebra of Lee association schemes over $\mathbb{Z}_4$*
John Vincent S. Morales (Tohoku University, Japan)

b) *Supereulerian Digraphs*
Hong-Jian Lai (West Virginia University, USA)

c) *A Dichotomy Theorem for Circular Colouring Reconfiguration*
Richard Brewster (Thompson Rivers University, Canada)

d) *On Permutation Arrays for Hamming Distance: Improving MOLS Bounds*
Ivan H. Sudborough (University of Texas at Dallas, USA)

12:10

Lunch

13:40

Coloring and List Coloring of the Squares of Graphs
Boram Park (Ajou University, Korea)

14:40

Coffee Break

15:00

a) *Maximal m-distance sets containing the representation of the Hamming graph $H(n, m)$*
Hiroshi Nozaki (Aichi University of Education, Japan)

b) *A Faster Algorithm for Computing Tutte Polynomials of Lattice Path Matroids*
Jacob Turner (University of Amsterdam, Netherlands)

c) *Generating theorem of even triangulation on the Klein bottle*
Yoshihiro Asayama (Yokohama National University, Japan)

d) *A Matrix-Weighted Zeta Function of a Graph*
Iwao Sato (Oyama National College of Technology, Japan)

15:20

15:25

a) *Spherical designs of some harmonic indices*
Kyoung-Tark Kim (Shanghai Jiao Tong University, China)

b) *On Covering Numbers of of Matroids*
Keisuke Shiromoto (Kumamoto University, Japan)

c) *Covering projective planar graphs with forests*
Raiji Mukae (National Institute of Technology, Miyakonojo College, Japan)

d) *Quaternionic quantum walks and zeta functions of graphs*
Hideo Mitsuhashi (Utsunomiya University, Japan)

15:45

15:50

a) *Relative t-designs in binary Hamming association schemes*
Yan Zhu (Shanghai Jiao Tong University, China)

b) *Catalan-like numbers and Hankel determinants*
Lili Mu (Dalian University of Technology, China)

c) *Hamiltonian Properties of Polyhedra with Few 3-Cuts*
Carol T. Zamfirescu (Ghent University, Belgium)

d) *Error correcting code from induced subgraphs of a complete graph K_n*
Sul-young Choi (Le Moyne College, USA)

16:10

Bush-type Hadamard matrices and applications

Hadi Kharaghani

University of Lethbridge, Canada

A Hadamard matrix $H = (H_{ij})_{i,j=1}^{2n}$ of order $4n^2$, where each H_{ij} is a square matrix of order $2n$, is said to be of *Bush-type* if $H_{ii} = J_{2n}$ for any $i \in \{1, \ldots, 2n\}$, and $H_{ij}J_{2n} = J_{2n}H_{ij} = 0$ for any distinct $i, j \in \{1, \ldots, 2n\}$, where J_{2n} is the square matrix of order $2n$ with all entries 1. Bush-type Hadamard matrices constitute the most prolific class of known regular Hadamard matrices. Furthermore, these matrices, due to their nice structure, lead to many new combinatorial objects.
This talk is a survey of Bush-type Hadamard matrices and their applications in designs, strongly regular graphs, mutually unbiased bases and association schemes.

Hereditary properties of simplicial complexes and h-triangles

Masahiro Hachimori

University of Tsukuba, Japan

In this talk, we consider simplicial complexes such that their restrictions to any of their vertex subsets as well as themselves have the same property $\mathcal{P}$. We say that such simplicial complexes satisfy hereditary-$\mathcal{P}$. As the required property $\mathcal{P}$, we consider shellability, partitionability, and sequential Cohen-Macaulayness. It is known that these properties (hereditary-shellability, hereditary-partitionability, and hereditary-sequential Cohen-Macaulayness) are equivalent for dimensions at most two, but the equivalence is open for higher dimensions. We discuss the possibility of showing such equivalence by using h-triangles.

Neighbour distinguishing graph colourings

Jakub Przybyło

AGH University of Science and Technology, Poland

Consider a simple graph $G = (V, E)$ and its *proper* edge colouring c with the elements of the set $\{1, 2, \ldots, k\}$. The colouring c is said to be *neighbour sum distinguishing* if for every pair of vertices u, v adjacent in G, the sum of colours of the edges incident with u is distinct from the corresponding sum for v (these sums also represent vertex degrees in a multigraph formed of G by multiplying each edge e of this graph $c(e)$ times, and are related with the origins of this concept, i.e., well studied graph invariant called *irregularity strength* of a graph). The least integer k for which such colouring exists is known as the *neighbour sum distinguishing index* of a graph and denoted by $\chi'_{\sum}(G)$. The definition of this parameter, which makes sense for graphs containing no isolated edges, immediately implies that $\chi'_{\sum}(G) \geq \Delta$, where Δ is the maximum degree of G. On the other hand, it was conjectured by Flandrin et al. that $\chi'_{\sum}(G) \leq \Delta + 2$ for all such connected graphs, except for C_5. We shall sketch a proof that this bound is asymptotically correct, as indeed $\chi'_{\sum}(G) \leq \Delta(1 + o(1))$. The main idea of the argument confirming this fact relays on a random assignment of the colours, where the choice for every edge is biased by so called *attractors*, randomly assigned to the vertices. The conjecture's exact bound in turn holds for several classes of graphs, as e.g. planar graphs of sufficiently large maximum degree. Similar results concerning the total version of the concept, as well as the protoplast of our problem focused on distinguishing neighbours by sets rather than sums shall also be discussed.

On SD-prime Labeling of Graphs

Gee-Choon Lau

MARA University of Technology, Malaysia

Let $G = (V(G), E(G))$ be a simple, finite and undirected graph of order n. Given a bijection $f : V(G) \to \{1, \ldots, n\}$, and every edge uv in $E(G)$, one can associate two integers $S = f(u)+f(v)$ and $D = f(u)-f(v)$. The labeling f induces an edge labeling $f' : E(G) \to \{0, 1\}$ such that for an edge uv in $E(G)$, $f'(uv) = 1$ if $gcd(S, D) = 1$, and $f'(uv) = 0$ otherwise. Such a labeling is called an SD-prime labeling if $f'(uv) = 1$ for all $uv \in E(G)$. We say G is SD-prime if it admits an SD-prime labeling. A graph G is said to be a strongly SD-prime graph if for every vertex v of G, there exists an SD-prime labeling f satisfying $f(v) = 1$. We investigate several results on this newly defined concept. In particular, we give a necessary and sufficient condition for the existence of an SD-prime labeling. This talk is based on joint work with Wai-Chee Shiu (Hong Kong Baptist University).

Double-weighted Paired-domination on Graphs

Yi-Hua Yang

National Tsing Hua University, Taiwan

We consider a generalization of the paired-domination problem. Given a connected graph $G = (V, E)$, a subset S of V is a paired-dominating set if every vertex not in S has at least a neighbor in S and the induced subgraph $G[S]$ contains a perfect matching.

We extend Lin and Hsieh's work (2014) and consider the *Double-weighted* paired-domination problem: given two types of weights $w_A(v)$ and $w_B(v)$ for each vertex v, the problem involves finding a paired-dominating set S in which every pair (u, v) of the perfect matching in $G[S]$ has weight $w_A(u) + w_B(v)$, such that the weight of S is minimized.

This talk is based on joint work with Ching-Chi Lin (National Taiwan Ocean University) and Chung-Shou Liao (National Tsing Hua University).

Multibasic Ehrhart theory

Aki Mori

Osaka University, Japan

The Ehrhart theory plays an important role when we study the relationship between the integral convex polytopes and the integer points. We introduce a multibasic extension of the Ehrhart theory, in which the number of integer points is replaced by a integer-point transform, which is a formal sum of monomials. We give a multibasic extension of Ehrhart polynomials and Ehrhart series. We also show that an analogue of Ehrhart reciprocity holds for multibasic Ehrhart polynomials.

This talk is based on joint work with Takeshi Morita (Osaka University) and Akihiro Shikama (Osaka University).

On directed versions of 1-2-3 Conjecture

Mariusz Woźniak

AGH University, Poland

Let $G = (V, E)$ be a finite, undirected simple graph. Karoński, Łuczak and Thomasson introduced and investigated a coloring of the edges of a graph with positive integers so that adjacent vertices have different sums of incident edge colors. More precisely, let $f : E \to \{1, 2, \ldots, k\}$ be an edge coloring of G (such a coloring is also called a k-coloring of G). For $x \in V$ we define

$$\sigma(x) := \sum_{e \ni x} f(e).$$

A k-coloring c of G is called *neighbor sum distinguishing* if $\sigma(x) \neq \sigma(y)$ whenever $xy \in E(G)$. In other words, the vertex coloring σ induced by f in the above described way must be proper.

The minimum integer k for which there is a neighbor sum distinguishing coloring of a graph G will be denoted by $\chi_\Sigma(G)$.

The following elegant problem, known as the *1-2-3 Conjecture*, was posed in 2004.

1-2-3 Conjecture. Let G be a connected graph, $G \neq K_2$. Then $\chi_\Sigma(G) \leq 3$.

Since its introduction, the 1-2-3 Conjecture has been attracting ingrowing attention, resulting in many research works considering either the conjecture itself or variants of it.

In the talk, we focus on the directed analogues of the 1-2-3 Conjecture. This talk is based mainly on joint work with Mirko Horňák (UPJS University, Košice, Slovakia) and Jakub Przybyło (AGH University, Cracow, Poland).

On Super (a, d)-star-antimagic total labeling of generalized Petersen graph

Mania Roswitha

Sebelas Maret University, Indonesia

In this talk we present some results on super (a, d)-star-antimagic total labeling of generalized Petersen graph. This talk is based on joint work with Co-author Karyanti (Sebelas Maret University) and Winita Sulandari (Sebelas Maret University). A graph G admits an (a, d)-H-antimagic total labeling if there is a bijective function $\xi : V(G) \cup E(G) \rightarrow \{1, 2, \ldots, |V(G)| + |E(G)|\}$ such that for all subgraphs H' isomorphic to H, the H-weights $w' = \Sigma_{v \in V(H')}\xi(v) + \Sigma_{e \in E(H')}\xi(e)$ constitute an arithmetic progression $a, a + d, a + 2d, \ldots, a + (t - 1)d$ where a and d are positive integers and t is the number of subgraphs of G isomorphic to H. Additionaly, G is said to be a super (a, d)-H- antimagic total labeling if $f(V) = \{1, 2, \ldots, |V|\}$.
Here we prove that every generalized Petersen $P(n, 1)$, n odd, is a super $(14n+3-3\lfloor \frac{n}{2} \rfloor, 2)$-$K_{1,3}$-antimagic total labeling, and every generalized Petersen $P(n, \frac{n-1}{2})$, n odd, admits a super $(13n + 4 - \lfloor \frac{n}{2} \rfloor, 2)$-$K_{1,3}$-antimagic total labeling. We also provide the largest possible value for a difference d.

Total domination and the annihilation number of a graph - on a conjecture of Graffiti.pc

Christoph Brause

TU Bergakademie Freiberg, Germany and *University of Johannesburg, South Africa*

The total domination number $\gamma_t(G)$, i.e. the minimum cardinality of a set of vertices S such that every vertex of G is adjacent to some vertex in S, and the annihilation number $a(G)$, i.e. the largest integer k such that the sum of the first k terms of the non-decreasing degree sequence of G is at most the size of G, are two known graph invariants. The conjecture-generating computer program, Graffiti.pc, conjectured that if G is a connected nontrivial graph, then $\gamma_t(G) \leq a(G) + 1$. It is known that the conjecture is true for trees and graphs of minimum degree at least 3. In this talk, we prove the conjecture for serveral graph classes, for example the class of graphs with minimum degree at least 2. In order to prove these results, we establish a new improved upper bound on $\gamma_t(G)$ in terms of the order of G.

Optimal Arrangements in Euclidean Space

Zongchen Chen

Shanghai Jiao Tong University, China

In this talk, I present some results on optimal arrangements in Euclidean space. An n-arrangement is a set of n points in Euclidean space such that the distance between every pair of points is at least one. The energy of an n-arrangement is the sum of squares of distances between all pairs of points. An n-arrangement is said to be optimal if its energy is minimal among all n-arrangements. Optimal arrangements on Euclidean plane are found for small n by computers. My talk focuses on two aspects: Firstly, I show the asymptotic behavior of energy of optimal n-arrangements in d-dimensional Euclidean space. Secondly, I describe the structure of optimal arrangements on Euclidean plane and prove the optimality of some arrangements for small n. This talk is based on joint work with Da Zhao (Shanghai Jiao Tong University).

On total weight choosability of graphs

Tsai-Lien Wong

National Sun Yat-sen University, Taiwan

A total-weighting of a graph $G = (V, E)$ is a mapping f which assigns to each element $y \in V \cup E$ a real number $f(y)$ as the weight of y. A total-weighting f of G is proper if the colouring ϕ_f of the vertices of G defined as $\phi_f(v) = \sum_{e \in E(v)} f(e) + f(v)$ is a proper colouring of G. For positive integers k, k', a graph G is called (k, k')-total-weight-choosable if whenever each vertex v is given k permissible weights and each edge e is given k' permissible weights, there is a proper total-weighting f of G which uses only permissible weights on each element $y \in V \cup E$. It was conjectured in [T. Wong and X. Zhu, Total weight choosability of graphs, J. Graph Theory 66 (2011), 198-212] that every graph is $(2, 2)$-total-weight-choosable, and every connected graph on more than one edge is $(1, 3)$-total-weight-choosable. In this talk, I will mention some results on total weight choosability of graphs and will sketch the proof of $(1, 3)$-total-weight-choosability for 2-degenerate nonbipartite graphs . This talk is based on joint work with Xuding Zhu(Zhejiang Normal University, China).

Cycle-Supermagic Covering on Sunflower Graph

Titin Sri Martini

Sebelas Maret University, Indonesia

A simple graph $G=(V,E)$ admits an H-covering, where H is subgraph of G, if every edge in E belongs to a subgraph of G isomorphic to H. Graph G is H-magic if there is a total labeling. G admits H-supermagic if there is a total labeling which label of vertex are 1, 2, until absolute V, and the total labeling is constant magic sum. This research defined Cycle supermagic covering on Sunflower graph.

This talk is based on joint work with Mania Roswitha (Sebelas Maret University) and Devi Ayu Lestari (University of Sebelas Maret).

On locating-dominating number of circulant graphs

Suhadi Wido Saputro

Institut Teknologi Bandung, Indonesia

Given a simple, connected, and finite graph G. The *open neighborhood* of a vertex v of G is defined as a vertex set $N(v) = \{u \in V(G) \mid uv \in E(G)\}$. The *locating-dominating number* of a graph G is defined as the cardinality of minimum of $W \subseteq V(G)$ such that for every two distinct vertices $u, v \in V(G) \setminus W$, $\emptyset \neq N(u) \cap W \neq N(v) \cap W \neq \emptyset$. A *circulant graph*, denoted by $C(n, \pm\{1, 2, \ldots, j\}), 1 \leq j \leq \left\lfloor \frac{n}{2} \right\rfloor, n \geq 3$, is defined as a graph with vertex set $V = \{v_0, v_1, \ldots, v_{n-1}\}$ and edge set $E = \{v_i v_j \mid |j-i| \equiv t(\mod n), t \in \{1, 2, \ldots, j\}\}$. In this paper, we study the locating-dominating set of circulant graphs $C(n, \pm\{1, 2, \ldots, j\})$ where $j \in \{1, 2, \ldots, \left\lfloor \frac{n}{2} \right\rfloor\}$. We also determine an exact value of locating-dominating number of circulant graphs $C(n, \pm\{1, 2, \ldots, j\})$ with $2 \leq j \leq 3$.

1-well-covered graphs and partial unimodality of independence polynomials

Eugen Mandrescu

Holon Institute of Technology, Israel

The independence polynomial $I(G;x)$ is the generating function of independents sets of a graph G (Gutman-Harary 1983). G is 1-well-covered (equivalently, $G \in W_2$) if every two disjoint independent sets are included in disjoint maximum independent sets (Staples 1975). We show that independence polynomials of 1-well-covered graphs are partially unimodal (namely, 2/3 of the coefficients of $I(G;x)$ appears in non-decreasing order). We conjecture that $I(G;x)$ is unimodal for $G \in W_2$.
This talk is based on joint work with Vadim E. Levit (Ariel University, Israel).

Bipartite polyhedral maps are disinguishing 3-colorable with few exceptions

Seiya Negami

Yokohama National University, Japan

A map or a graph embedded on a closed surface is said to be *polyhedral* if it is 3-connected and if any two faces meet in at most one vertex or at most one edge, and is said to be *distinguishing k-colorable* if it has a k-coloring such that no map-automorphism other than the identity map preserves the colors. We shall show that bipartite polyhedral maps are distinguishing 3-colorable with very few exceptions, developing a theory to specify the exceptions, which will lead us to some new subjects for other research. This work has been established as joint work with K. Noguchi (Tokyo Denki University) and T. Tucker (Colgate University).

On the edge irregularity strength of corona product of graphs with cycle

Roslan Hasni

Universiti Malaysia Terengganu (UMT), Malaysia

For a simple graph G, a vertex labeling $\phi : V(G) \to \{1, 2, \cdots, k\}$ is called k-labeling. The weight of an edge xy in G, denoted by $w_\pi(xy)$, is the sum of the labels of end vertices x and y, i.e. $w_\phi(xy) = \phi(x)+\phi(y)$. A vertex k-labeling is defined to be an edge irregular k-labeling of the graph G if for every two different edges e and f, there is $w_\phi(e) \neq w_\phi(f)$. The minimum k for which the graph G has an edge irregular k-labeling is called the edge irregularity strength of G, denoted by $es(G)$. In this talk, we determine the exact value of edge irregularity strength of corona product of graphs with cycle.

Results on expansion of global secure sets

Hsin-Hao Lai

National Kaohsiung Normal University, Taiwan

Let G be a graph and S be a nonempty subset of $V(G)$. The set S is secure if $\forall X \subseteq S$, $|N[X] \cap S| \geq |N[X] - S|$ where $N[X]$ is the closed neighborhood of X. A secure set S is called a global secure set of G if it is a dominating set of G. A global secure set S is expandable if there exists a vertex v not in S such that the set $S \cup \{v\}$ is a global secure set.

In this talk, I will present some results on expandable global secure sets.

Symmetric, unimodal and gamma-nonnegative polynomials in combinatorics and geometry

Christos Athanasiadis

University of Athens, Greece

Gamma-nonnegativity is a useful tool to prove that certain polynomials with symmetric coefficients are unimodal. It appeared in the seventies in work of Foata and Schützenberger on the classical Eulerian polynomials and attracted attention more recently after work of Bränden on poset Eulerian polynomials and Gal on flag simplicial spheres. This talk will survey results and open problems related to gamma-nonnegativity in enumerative and geometric combinatorics, with an emphasis on permutation enumeration and the combinatorics of flag triangulations of balls and spheres.

Smith normal form and combinatorics

Richard P. Stanley

Massachusetts Institute of Technology, USA

Let R be a commutative ring (with identity) and A an $n \times n$ matrix over R. Suppose there exist $n \times n$ matrices P, Q invertible over R for which PAQ is a diagonal matrix $\mathrm{diag}(\alpha_1, \ldots, \alpha_r, 0, \ldots, 0)$, where α_i divides α_{i+1} in R. We then call PAQ a *Smith normal form* (SNF) of A. If R is a principal ideal domain (PID) then an SNF always exists and is unique up to multiplication by units.

We will survey some connections between SNF and combinatorics. Topics will include (1) the general theory of SNF, (2) a close connection between SNF and chip firing in graphs, (3) the SNF of a random matrix of integers (joint work with Yinghui Wang), (4) SNF of special classes of matrices, including some arising in the theory of symmetric functions and the theory of hyperplane arrangements, and (5) an example of SNF over a non-PID (with Christine Bessenrodt).

On 2-factors through specified perfect matchings in bipartite graphs

Shuya Chiba

Kumamoto University, Japan

A 2-*factor* of a graph G is a spanning subgraph of G in which every component is a cycle. In 1997, Brandt, Chen, Faudree, Gould, Lesniak [Degree conditions for 2-factors, J. Graph Theory 24 (2) (1997), 165–173] considered the degree condition for the existence of 2-factors with k cycles in general graphs, which is a generalization of Ore's classical theorem on the existence of Hamilton cycles. In this talk, we will present some results on the degree conditions for the existence of 2-factors with k cycles including every edge of a specified perfect matching in bipartite graphs, and we will discuss about a relationship between our result and the result of Brandt et al.

Some conditions on $G[V_5(G)]$ for a 5-connected graph G to have a contractible edge

Kiyoshi Ando

National Institute of Informatics, JST ERATO Kawarabayashi Large Graph Project, Japan

Let k be an integer such that $k \geq 2$ and let G be a connected graph with connectivity k and $|V(G)| \geq k+2$. Let $G[V_k(G)]$ denote the subgraph of G induced by the set of degree k vertices. An edge of G is said to be *contractible* if the contraction of it results in a k-connected graph. Let G be a 5-connected graph. We prove that if $G[V_5(G)]$ has an induced cycle, then G has a contractible edge. In the talk we present some more conditions on $G[V_5(G)]$ for G to have a contractible edge.

Graph parameters from symplectic group invariants

Bart Sevenster

University of Amsterdam, the Netherlands

In this talk we introduce, and characterize, a class of graph parameters obtained from tensor invariants of the symplectic group. These parameters are similar to partition functions of vertex models, as introduced by de la Harpe and Jones, [P. de la Harpe, V.F.R. Jones, Graph invariants related to statistical mechanical models: examples and problems, *Journal of Combinatorial Theory*, Series B **57** (1993) 207–227]. Yet they give a completely different class of graph invariants. We moreover show that certain evaluations of the cycle partition polynomial give examples of graph parameters that can be obtained this way.

This talk is based on joint work with Guus Regts (University of Amsterdam).

Tiling of the Sphere by Almost Equilateral Pentagons

Min Yan

Hong Kong University of Science and Technology, Hong Kong

The classification of edge-to-edge tilings of the sphere by congruent triangles was completed by Ueno and Agaoka in 2002. We started working on the classification of edge-to-edge tilings of the sphere by congruent pentagons. The first result was the JCTA 2013 paper on complete classification for the minimal case of tilings by 12 pentagons. The further work is divided into three parts:

1. Variable edge length;
2. Equilateral: all five edges have equal length;
3. Almost equilateral: four edges have equal length, and the fifth edge has different length.

The first two parts are relatively easier than the third part. In JCCA 2014, I talked about the technique for dealing with the first two parts.

In this talk, I will concentrate on the third part. We will discuss the technique for solving the simplest cases of the part. Then we will also discuss some observations on the more difficult cases that we hope may help us developing additional techniques. We hope that these techniques can eable us to complete the classification.

This talk is based on joint work with Luk Hoiping (Hong Kong University of Science and Technology).

Connected even factors in the square of 2-edge connected graphs

Jan Ekstein

University of West Bohemia, Czech Republic

An essentially k-edge connected graph G is a connected graph such that deleting less than k edges from G cannot result in two nontrivial components. In this talk we prove that if an essentially 2-edge connected graph G satisfies that for any pair of leaves at distance 4 in G there exists another leaf of G that has distance 2 to one of them, then the square G^2 has a connected even factor with maximum degree at most 4. Moreover we show that, in general, the square of essentially 2-edge connected graph does not contain a connected even factor with bounded maximum degree. This talk is based on joint work with Liming Xiong (Beijing Institute of Technology) and Baoyindureng Wu (Xinjiang University).

A heuristic approach to dividing graphs into bi-connected components of specified size

Raka Jovanovic

Hamad bin Khalifa University, Qatar

In this talk we focus on the problem of dividing graphs into bi-connected subgraphs with a maximal allowed size. The problem is solved using a greedy procedure that exploits the fact that each bi-connected graph has an ear decomposition. The algorithm is based on a breadth first search (BFS) that also tracks additional properties of the nodes in the BFS tree. In practice the method consists in growing several subgraphs in parallel, with some auxiliary corrections applied to the corresponding BFS trees. The performance of the basic algorithm is improved by adding randomization and incorporating a local search procedure.

On the chromatic number of zero-divisor graphs of modules

Rezvan Varmazyar

Islamic Azad University, Iran

Let R be a commutative ring with identity. Let A_1 and A_2 be multiplication R-modules. In this talk we investigate some properties about zero-divisor graphs of $A_1 \oplus A_2$.

Learning a hidden uniform hypergraph

Huilan Chang

National University of Kaohsiung, Taiwan, ROC

The complex model of group testing can be formulated as a problem of learning a hidden graph by edge-detecting queries, each of which tells whether a set of vertices induces an edge of the hidden graph or not. The information-theoretic lower bound of learning a hidden r-uniform hypergraph with n vertices and m edges is $\Omega(mr \log n)$. We provide an adaptive algorithm to learn such a hidden graph within $mr \log n + (6e)^r m^{\frac{r+1}{2}}$ edge-detecting queries.
This is joint work with Hung-Lin Fu and Chih-Huai Shih.

On s-hamiltonian line graphs of claw-free graphs

Mingquan Zhan

Millersville University of Pennsylvania, USA

For an integer $s \geq 0$, a graph G is s-hamiltonian if for any vertex subset $S \subseteq V(G)$ with $|S| \leq s$, $G - S$ is hamiltonian, and G is s-hamiltonian connected if for any vertex subset $S \subseteq V(G)$ with $|S| \leq s$, $G - S$ is hamiltonian connected. Recently Lai and Shao [J. Graph Theory, 74 (2013)] proved that for a connected graph G and an integer $s \geq 5$, the line graph $L(G)$ is s-hamiltonian if and only if $L(G)$ is $(s+2)$-connected. They raised an open problem whether a line graph $L(G)$ is s-hamiltonian if and only if $L(G)$ is $(s+2)$-connected for $s \in \{2, 3, 4\}$. In 1984, Thomassen conjectured that every 4-connected line graph is hamiltonian. In this paper we investigate the line graph of a claw-free graph, and prove that
(i) For $s \in \{2, 3, 4\}$, every line graph $L(G)$ of a claw-free graph is s-hamiltonian if and only if $L(G)$ is $(s+2)$-connected.
(2) Every 4-connected line graph of a claw-free graph is 1-hamiltonian connected.
This talk is based on joint work with Drs. Hong-Jian Lai (West Virginia University), Taoye Zhang (Penn State Worthington Scranton), Ju Zhou (Kutztown University).

Highly connected subgraphs in sparse graphs

Henry Liu

Central South University, China

Let G be a graph on n vertices with independence number α. How large a k-connected subgraph must G contain? It turns out that if n is sufficiently large ($n \geq \alpha^2 k + 1$ will do), then G always contains a k-connected subgraph on at least n/α vertices. This is sharp, since G might be the disjoint union of α equally-sized cliques. What if n is *not* sufficiently large? We shall present the (surprisingly complicated) answer when $\alpha = 2$ and $\alpha = 3$. This talk is based on joint work with Shinya Fujita (Yokohama City University, Japan) and Amites Sarkar (Western Washington University, USA).

Travel groupoids and combinatorial structures on a graph

Yoshio Sano

University of Tsukuba, Japan

The notion of travel groupoids was introduced by L. Nebeský in 2006 in connection with study on shortest paths in graphs. A *travel groupoid* is the pair $(V, *)$ of a nonempty set V and a binary operation $*$ on V satisfying the following axioms: (t1) $(u * v) * u = u$ (for all $u, v \in V$); (t2) if $(u * v) * v = u$, then $u = v$ (for all $u, v \in V$). For a travel groupoid $(V, *)$ and a graph G, we say that $(V, *)$ *is on* G or that G *has* $(V, *)$ if $V(G) = V$ and $E(G) = \{\{u, v\} \mid u, v \in V, u \neq v, \text{ and } u * v = v\}$.

In this talk, we consider some combinatorial structures defined on a graph, and we give bijections between the set of all travel groupoids on a graph and combinatorial structures on the graph. This talk is based on joint work with Jung Rae Cho (Pusan National University) and Jeongmi Park.

A variant of hypercube with small diameter

Xuding Zhu

Zhejiang Normal University, China

This talk introduces a new variant of hypercubes, the Z-cubes. The n-dimensional Z-cube H_n is obtained from two copies of the $(n-1)$-dimensional Z-cube H_{n-1} by adding a perfect matching between the vertices of these two copies of H_{n-1}. We prove that the n-dimensional Z-cubes H_n has diameter $(1+o(1))n/\log_2 n$. This greatly improves on the previous known variants of hypercube of dimension n, whose diameters are all larger than $n/3$. Moreover, any hypercube variant of dimension n is an n-regular graph on 2^n vertices, and hence has diameter greater than $n/\log_2 n$. So the Z-cubes are optimal with respect to diameters, up to an error of order $o(n/\log_2 n)$. Another type of Z-cubes $Z_{n,k}$ which have similar structure and properties as H_n are also discussed in the last section.

Hamilton cycles in line graphs

Tomáš Kaiser

University of West Bohemia, Czech Republic

The theme of this talk is the conjecture of Thomassen (1986) that every 4-connected line graph admits a Hamilton circuit. We review the history and the status of the problem, outline the proof of Kaiser and Vrána (2012) for 5-connected line graphs with minimum degree ≥ 6, and discuss related results and questions. The talk is partly based on joint work with Petr Vrána and with Zdeněk Ryjáček.

Ehrhart polynomials of lattice simplices and linear binary code

Akihiro Higashitani

Kyoto Sangyo University, Japan

Ehrhart polynomials of lattice polytopes are the enumerative function counting the lattice points contained in the dilation of a given lattice polytope. In this talk, after introducing some elements of Ehrhart theory, we focus on the Ehrhart polynomials of lattice simplices and present some results on a relation between them and linear binary codes.

On q-integrals over order polytopes

Jang Soo Kim

Sungkyunkwan University, Korea

In this talk we express a q-integral over an order polytope coming from a poset as a sum over all linear extensions of the poset. As an application, we give a combinatorial interpretation of a q-Selberg integral, which generalizes Stanley's combinatorial interpretation of the Selberg integral. This is joint work with Dennis Stanton.

Triple product formulae for boxed plane partitions derived from orthogonal polynomials

Shuhei Kamioka

Kyoto University, Japan

A generalization of MacMahon's triple product formula for boxed plane partitions is derived by means of orthogonal polynomials. A combinatorial interpretation of orthogonal polynomials in terms of (non-intersecting) lattice paths directly connects orthogonal polynomials with plane partitions. The interpretation is used to derive from the little q-Laguerre polynomials a new triple product formula for plane partitions which generalizes MacMahon's triple product formula as well as the trace generating function by Stanley.

Evacuation and cyclic sieving on partitions

Sen-Peng Eu

National Taiwan Normal University & Chinese Air Force Academy, Taiwan

We investigate the evacuation operation over chains induced by a partition shape and obtain cyclic sieving results for certain shapes.

Association schemes and almost distance-regular graphs

Edwin van Dam

Tilburg University, the Netherlands

This talk is based on joint work with Jack Koolen and Jongyook Park.

Strongly regular graphs with the same parameters as the symplectic graph

Sho Kubota

Tohoku University, Japan

We consider orbit partitions of groups of automorphisms for the symplectic graph and apply Godsil-McKay switching. As a result, we find four families of strongly regular graphs with the same parameters as the symplectic graphs, including the one discovered by Abiad and Haemers. Also, we prove that switched graphs are non-isomorphic to each other by considering the number of common neighbors of three vertices.

On equiangular lines and regular graphs

Gary Greaves

Tohoku University, Japan

Given some dimension d, what is the maximum number of lines in $\mathbb{R}^d$ such that the angle between any pair of lines is constant? (Such a system of lines is called "equiangular".) This classical problem was initiated by Haantjes in 1948 in the context of elliptic geometry. In 1966, Van Lint and Seidel showed that graphs could be used to study equiangular line systems.

In this talk we present some recent results on equiangular lines in Euclidean spaces. In particular, we will highlight the cases when large sets of equiangular lines correspond to regular graphs with few distinct eigenvalues.

On a lower bound on the Laplacian eigenvalues of a graph

Akihiro Munemasa

Tohoku University, Japan

If μ_m and d_m denote, respectively, the m-th largest Laplacian eigenvalue and the m-th largest vertex-degree of a graph, then $\mu_m \geq d_m - m + 2$ holds. This inequality was conjectured by Guo in 2007 and proved by Brouwer and Haemers in 2008. Brouwer and Haemers gave several examples of graphs achieving equality, but a complete characterization was not given. In this talk we report on the problem of characterizing graphs satisfying $\mu_m = d_m - m + 2$.

This talk is based on joint work with Gary Greaves (Tohoku University) and Anni Peng (Tongji University).

A generalization of a Hoffman's theorem

Jae young Yang

POSTECH, South Korea

In this talk, I will summarize my two papers about Hoffman graph. First paper is about structure theory of graphs with bounded smallest eigenvalue. Second paper is about a generalization of a Hoffman's theorem, which is published in 1977. Main tool of those two papers is Hoffman graph, which is a graph with labeling function. This talk is based on joint work with Jack Koolen and Qian Qian Yang.

Spectral and stochastic behaviors of Grover walks

Etsuo Segawa

Tohoku University, Japan

We consider the Grover walks on graphs. One of the nice properties of the Grover walk is that the spectrum can be decomposed into the inherited part from the underlying isotropic random walk and the birth part which reflects flow of the graph. As applications of this useful fact, we provide the Jordan normal form of positive supports of 1-st, square and cube Grover walks which are related to the Ihara zeta function with some conditions. Moreover, we report our results on limit theorems of the Grover walks on some crystal lattices and also regular trees.

Multi-way expanders and imprimitive group actions on graphs

Masato Mimura

Tohoku University, Japan

For $n \geq 2$, the concept of **"n-way expander graphs"**, in terms of multi-way isoperimetric constants, was defined by various researchers. Bigger n gives a weaker notion in general, and 2-way expander graphs coincide with **"expander graphs"** in ordinary sense. Koji Fujiwara (Kyoto University) asked whether these concepts are equivalent to that of ordinary expander graphs for all n for a sequence of Cayley graphs. We answer his question in the affirmative. More precisely, we establish *universal inequalities* on multi-way isoperimetric constants on any finite, connected, and vertex-transitive graph.

Coloring some perfect graphs

Maria Chudnovsky

Princeton University, USA

Perfect graphs are a class of graphs that behave particularly well with respect to coloring. In the 1960's Claude Berge made two conjectures about this class of graphs, that motivated a great deal of research, and by now they have both been solved.

The following remained open however: design a combinatorial algorithm that produces an optimal coloring of a perfect graph. Recently, we were able to make progress on this question, and we will discuss it in this talk. Last year, in joint work with Lo, Maffray, Trotignon and Vuskovic we were able to construct such an algorithm under the additional assumption that the input graph is square-free (contains no induced four-cycle). More recently, together with Lagoutte, Seymour and Spirkl, we solved another case of the problem, when the clique number of the input graph is fixed (and not part of the input).

A new approach to the four color theorem via associahedra

Yuhei Inoue

Tohoku University, Japan

The four color theorem is known as a theorem whose proof is very long. Bowlin and Brin tried to obtain a shorter proof of the theorem using binary trees, associahedron and an infinite group known as Thompson's F in 2013. The n-dimensional associahedron is a graph composed by binary trees having $n-2$ leaves. They proved that, if for any pair of vertices D and R in the associahedron, there is a good path called a "valid path" from D to R, then the four color theorem follows. We consider the distance in the n-dimensional associahedron, and proved that for any pair of vertices D and R in the n-dimensional associahedron which have distance n, exists a valid path from D to R. In addition, we found a family $\{G_{n-2,k} \mid 0 \leq k \leq n-2\}$ of vertices in the n-dimensional associahedron such that for every vertex D there is a valid path from D to $G_{n,k}$ for some k under a certain assumption. In this talk, we will introduce the relationship between the four color theorem and associahedra, and our results.

Lattice simplices having small degrees

Akihiro Higashitani

Kyoto Sangyo University, Japan

For each lattice polytope $P \subset \mathbb{R}^d$, which is a convex polytope all of whose vertices belong to $\mathbb{Z}^d$, the degree $\deg(P)$ can be defined and it is one of the most important invariants which measure a "size" of P. In this talk, we present some results on the structure of the lattice polytopes having degree at most 2. This talk is based on joint work with Johannes Hofscheier (Magdeburg University).

Critical groups of strongly regular graphs

Joshua E. Ducey

James Madison University, USA

The critical group of a graph is an interesting isomorphism invariant that has been receiving much attention recently. Determining this group is equivalent to computing the Smith normal form of the Laplacian matrix of the graph. In this talk we demonstrate a technique that yields information about the critical group of any strongly regular graph. As an application, we learn much about the critical group of a hypothetical Moore graph of diameter 2 and valency 57.

A cluttered ordering for a bipartite graph

Tomoko Adachi

Toho University, Japan

We can make a model of disk arrays by corresponding an information disk to a vertex and a check disk to an edge. Minimizing the number of disk operations leads to the concept of a cluttered ordering. For each positive integer h and t, we define a bipartite graph denoted by $H(h;t) = (U, E)$. It has $2h(t+1)$ vertices and $th(2h+1)$ edges. Mueller et al. (2005) gave cyclic constructions of $H(1;t)$, $H(2;t)$ and $H(h;1)$. Adachi and Kikuchi (2015) gave one of $H(3;t)$. In this talk, we investigate $H(4;t)$.

Kempe equivalence of 3-edge-colorings in cubic graphs on the projective plane

Kenta Ozeki

National Institute of Informatics / JST, ERATO, Kawarabayashi Large Graph Project, Japan

Let G be a cubic graph with 3-edge-coloring c. For an alternating cycle (i.e. 2-edge-colored cycle) D, a *Kempe switch (at D)* is an operation to obtain another 3-edge-coloring by changing the colors of $E(D)$. Two 3-edge-colorings are *Kempe equivalent* if one is obtained from the other by the sequence of Kempe switches. If G is embedded on the plane or the projective-plane, Kempe equivalence is related to topological properties of them. We show that bipartite cubic graphs G on the projective-plane admits only one Kempe equivalent class if and only if the dual G^* is not vertex-4-colorable.

FFLV Polytopes and Their Vertices

Igor Makhlin

National Research University HSE, Russia

The Feigin-Fourier-Littelmann-Vinberg polytope is a convex polytope with lattice points enumerating a basis in an irreducible $\mathfrak{sl}_n$-module. We present explicit descriptions of the set of such a polytope's vertices and two subsets thereof: the simple vertices and vertices corresponding to Weyl group translates of the highest weight. These vertices and subsets are of significance in the geometry of degenerate flag varieties as well as representation theory. We show that they can be controlled in terms of certain appealing combinatorial structures. This talk is based on joint work with Evgeny Feigin (NRU HSE).

2-arc-transitive graphs of order 4p

Mohsen Ghasemi

Urmia University, Iran

A graph X is said to be *k-arc-transitive* if the automorphism group of X, denoted Aut(X), acts transitively on the k-arcs of X. In this talk we classify 2-arc-transitive graphs of order $4p$.

On a lower bound graph of a lattice

Gen Kawatani

Yokohama National University, Japan

For a poset $P = (X, \leq)$, the LB-*graph* is the graph $G = (X, E)$, where $uv \in E$ if and only if $u \neq v$ and there exists $x \in X$ such that $x \leq u, v$. We say that a graph G is a LB-graph if there exists a poset whose LB-graph is isomorphic to G. If P is a lattice, then the LB-graph is a complete graph because every pair of elements in a lattice has a lower bound. Therefore, the speaker considered a LB-graph of a lattice without a minimal element and obtained a characterization of the graph. This is joint work with M.Tsuchiya (Tokai Univ.).

Z_3-connectivity of triangularly-connected graphs

Ju Zhou

Kutztown University of Pennsylvania , USA

A graph G is k-triangular if each edge of G is in at least k triangles. It is conjectured that every 4-edge-connected 1-triangular graph admits a nowhere-zero Z_3-flow. We first proved that not all such graphs are Z_3-connected. We further showed that every 4-edge-connected 2-triangular graph is Z_3-connected. The result is best possible. This result provides evidence to support the Z_3-connectivity conjecture by Jaeger et al that every 5-edge-connected graph is Z_3-connected.

Volume of Gorenstein Fano polytopes arising from order polytopes and chain polytopes

Akiyoshi Tsuchiya

Osaka University, Japan

Richard Stanley introduced the order polytope and the chain polytope arising from a finite partially ordered set, and gave the formula of the volume of these polytopes in terms of the underlying partially ordered set. On the other hand, we can construct three types of Gorenstein Fano polytopes by using order polytopes and chain polytopes. In this talk we present the formula of the volume of these three polytopes in terms of the underlying partially ordered sets.

Asymmetry of tournaments and some related results

Shohei Satake

Nagoya University, Japan

In 1963, Erdős and Rényi investigated the asymmetry of undirected graphs.

In this talk, we investigate the asymmetry of tournaments. First, we define the asymmetry number of finite tournaments and show an asymptotically best possible upper bound by considering finite random tournament. Next, we deal with countable tournaments. Countable random tournaments are almost surely isomorphic to a symmetric tournament RT. We show that $\mathrm{Aut}(RT)$ has $2^{\aleph_0}$ members and some results about $\mathrm{Aut}(RT)$.

This talk is based on joint work with Masanori Sawa (Kobe University).

A generalization of vertex rankings of graphs

Jobby Jacob

Rochester Institute of Technology, U.S.A.

For a graph G, a function $f : V(G) \to \{1, 2, \ldots, k\}$ is a (vertex) k-ranking, if $f(u) = f(v)$ implies that every $u - v$ path contains a vertex x such that $f(x) > f(u) = f(v)$. The rank number of a graph G is the minimum value of k such that G has a k-ranking. Hence the rank number of a graph is obtained by applying the l_∞ norm (max norm) to the vertex labels. Jamison and Narayan studied the rank numbers of graphs based on the l_1 norm (sum norm).

In this talk, we will look at a generalization of vertex rankings based on l_p norms for $1 \leq p < \infty$. We will compare rank numbers based on l_p norms for $1 \leq p < \infty$ to the traditional rank number for some classes of graphs. We will also discuss the cases where $0 \leq p < 1$.

This talk is based on joint work with Bonnie Jacob (National Technical Institute for Deaf at Rochester Institute of Technology).

Crossing Roads in Combinatorial Optimization: The Salesman, The Postman and Polyhedra

András Sebő

CNRS, Laboratoire G-SCOP, Université Grenoble-Alpes, France

I am reporting on a new wave of ideas in combinatorial optimization using tools from other parts of mathematics and from classical combinatorial optimization to tackle various old and new problems.

I try to demonstrate on the example of the Travelling Salesman Problem, how strong meta-methods may predict possibilities, and then be replaced by better suited elementary results. The pillars of combinatorial optimization such as matroid intersection, matchings, T-joins, graph connectivity, used in parallel with elements of freshmen's probabilities, and linear programming, appropriately merged with newly developed ideas tailored for the problems, may not only replace difficult generic arguments, but also essentially improve the results.

For instance, the approximation guarantee of the TSP for graph metrics has been improved (from Christofides' 3/2 then Gharan, Saberi and Singh's 3/2− eps) to 7/5, gradually, along with a 4/3 approximation algorithm for minimum cardinality 2-edge-connected subgraphs; the best possible 3/2 integrality gap for the path-TSP with graph-metrics has been reached (joint results with Jens Vygen). For the general s-t-path-TSP to $3/2 + 1/34$ has been proved, just 1/34 away from the best possible in terms of the integrality gap (joint work with Anke van Zuylen, April 2016). All of these make use of the mentioned tools, and of the postman's and salesman's very different, but crossing roads, as I try to show.

Sum List Colorings of Graphs

Arnfried Kemnitz

Technical University of Braunschweig, Germany

Given a simple graph $G = (V, E)$ and a function f from V to the positive integers, f is called a *choice function* of G if there is a proper vertex coloring ϕ such that $\phi(v) \in L(v)$ for all $v \in V$, where $L(v)$ is any assignment of $f(v)$ colors to v. The *sum choice number* $\chi_{sc}(G)$ of G is defined to be the minimum of $\sum_{v \in V} f(v)$ over all choice functions f of G. In this talk we provide several new lower bounds on $\chi_{sc}(G)$ in terms of subgraphs of G. This talk is based on joint work with Jochen Harant (Ilmenau University of Technology).

A new universal cycle for permutations

Dennis Wong

Northwest Missouri State University, USA

In this talk we introduce a new notation, the relaxed shorthand notation, to encode n-permutations of a character set $\langle n \rangle = \{1, 2, \ldots, n\}$. We then present a simple shift rule that exhaustively lists out each n-permutation of $\langle n \rangle$. The shift rule induces a Gray code for n-permutations of $\langle n \rangle$ where successive strings differ by a rotation or a shift. By concatenating the first symbol of each string in the listing, we produce a universal cycle for n-permutations of $\langle n \rangle$ in relaxed shorthand notation. We also show that the universal cycle can be constructed in $O(1)$-amortized time per symbol using $O(n)$ space.

Some existence of splitting BIB designs

Kazuki Matsubara

Chuo Gakuin University, Japan

The concept of splitting balanced incomplete block (BIB) designs $\mathrm{B}(v, u \times k, \lambda)$ has been defined with some applications for authentication codes in Ogata, Kurosawa, Stinson and Saido (2004). There has been some works on the existence of splitting BIB designs. In this talk, we present some construction methods of splitting BIB designs by use of other combinatorial structures and show interesting results on the existence problem of splitting BIB designs. This talk is based on joint work with Sanpei Kageyama (Tokyo University of Science).

Signed Sum Free Sets

Angelica Klosky

Gettysburg College, United States

A subset A of a given finite abelian group G is called H-signed-sum-free if for any distinct h_1 and h_2 in the index set H, the signed sum of h_1 elements from A is never equal to the signed sum of h_2 elements in A. A subset A is maximal H-signed-sum-free if all subsets of larger size than A are not H-signed-sum-free. In this talk about signed sum free sets I present a comprehensive formula for the maximum size of $\{2, 1\}$ signed sum free sets in finite cyclic groups as well as bounds for cases involving other index sets.

On r-Equitable Coloring of Graph Products

Chih-Hung Yen

National Chiayi University, Taiwan, R.O.C.

A (proper) k-coloring of a graph G is a mapping from the vertex set $V(G)$ to the set $\{1, 2, \ldots, k\}$ such that adjacent vertices have different images. The images $1, 2, \ldots, k$ are called colors and all vertices of a fixed color constitute a color class. For some integer $r \geq 0$, a k-coloring of G is said to be r-equitable if the sizes of any two color classes differ by at most r. In this talk, we present some results on r-equitable coloring of Kronecker products of graphs and Cartesian products of graphs, respectively. This talk is based on joint work with Chao-Chun Chen and Zi-Yi Yang (National Chiayi University).

On the Maximal Matching Polytope

Mustafa Kemal Tural

Middle East Technical University, Turkey

Given a weighted simple graph, the minimum weighted maximal matching (MWMM) problem is the problem of finding a maximal matching of minimum weight. The MWMM problem is NP-hard in general, but is polynomial-time solvable in some special classes of graphs when all the edge weights are equal to one. We study the MWMM problem from a polyhedral point of view and consider the linear programming relaxation of a recently proposed integer programming formulation for the problem. After studying some properties of this relaxation, we introduce some valid inequalities for the maximal matching problem generalizing some of the previously known inequalities.

On symmetric BIBDs with the same 3-subset multiplicity

Da Zhao

Shanghai Jiao Tong University, China

In this talk we present some results on combinatorial designs. In a symmetric balanced block design, each pair of points appears the same times. We consider the existence of two distinct SBIBDs with the same triple multiplicity. Such pair of designs can give a non-trivial tight relative 3-design on two shells in the Hamming association scheme $H(n, 2)$. We show that such pairs don't exist in most parameters. We give criteria to check the existence when designs are given and give some computational results. This talk is based on joint work with ZongChen Chen (Shanghai Jiao Tong University).

Refinement of the structure constants in the class-sum algebra of the symmetric group

Jacob Katriel

Technion - Israel Institute of Technology, Israel

Let A, B, C be conjugacy class-sums in S_n. The coefficient of C in the product of A and B can be determined in terms of the following enumeration problem within S_m, where m is the *smallest* of the support-sizes of A, B and C: Let $\lambda_1, \lambda_2, \cdots, \lambda_k$ be the cycles of $u \in U$ and $\mu_1, \mu_2, \cdots, \mu_\ell$ those of $v \in V$, where U, V (and W) are conjugacy classes in S_m. Let $R_{i,j}$ be the number of common indices in the cycles λ_i and μ_j. The cardinality of $\{(x, y) \in U \times V | xy \in W, x \cap y = R\}$ has to be determined.

Maximal edge-colorings of graphs

Mariusz Meszka

AGH University of Science and Technology, Poland

A *maximal edge-coloring* of a graph G of order n is a proper edge-coloring of G with $\chi'(K_n)$ colors such that no edge of the complement $\overline{G}$ of G can be attached to G without violating conditions of proper edge-coloring. For given n, a *spectrum* $MEC(n)$ is defined to be the set of all sizes of graphs of order n which admit maximal edge-colorings.

Several constructions will be presented in order to conclude the main result that almost completely determines spectrum $MEC(n)$.

Approximation Algorithms for the Steiner Tree Problem with the Bounded Edge-length

Chi-Yeh Chen

National Cheng Kung University, Taiwan, ROC

In this talk we present some results on the Steiner Tree Problem with the Bounded Edge-length. This talk is based on joint work with Chi-Yeh Chen (National Cheng Kung University). This work considers the Steiner tree problem with the bounded edge-length d where d is the ratio of the maximum edge cost to the minimum edge cost. The approximation algorithm has an approximation ratio of $\frac{d \ln 4}{d+\ln 4-1} + \epsilon$. For quasi-bipartite graphs, the algorithm achieves approximation ratio of $\frac{73 \cdot d}{60 \cdot d+13} + \epsilon$. The algorithm implies approximation ratio of $1.162 + \epsilon$ for the problem on complete graphs with edge distances 1 and 2.

On the existence of $S(3, \{4, 5, 7\}, v)$

Li Yun

Soochow University, China

Let $B_3(K) = \{v : \text{there is an S}(3, K, v)\}$. For $K = \{4\}$ or $\{4, 6\}$, $B_3(K)$ has been determined by Hanani, and for $K = \{4, 5\}$ or $\{4, 5, 6\}$ by Ji Lijun. In this talk, we investigate the case of $K = \{4, 5, 7\}$. A necessary condition of $v \in B_3(\{4, 5, 7\})$ is $v \equiv 1, 2, 4, 5 \pmod{}$. It is known that $B_3(\{4, 5\}) = \{v > 0 : v \equiv 1, 2, 4, 5, 8, 10 \pmod{12}, v \neq 13\} \subset B_3(\{4, 5, 7\})$, and that there is an $S(3, \{4, 5, 7\}, v)$ for $v \equiv 7 \pmod{12}$ with $v \neq 19$ by Ji Lijun. We need to consider the case $v \equiv 11 \pmod{12}$. It is proved that $B_3(\{4, 5, 7\}) \cup \{19, 23\} = \{v > 0 : v \equiv 1, 2, 4, 5 \pmod{6}, v \neq 13\}$. This talk is based on joint work with Ji Lijun(Soochow University).

Trees and Regularity of Binomial Edge Ideals

Narayanan N

Indian Institute of Technology Madras, Indian

Edge ideals of graphs and the relation between their algebraic properties and the graph invariants is receiving a lot of attention in the recent years.

In this talk we present improved lower bound for the regularity of the binomial edge ideals of trees. We then prove an upper bound for the regularity of the binomial edge ideals proposed by Saeedi Madani and Kiani for a subclass of block graphs called $clique - path$ graphs. As a consequence we obtain sharp upper and lower bounds for the regularity of binomial edge ideals of the class of trees called lobsters.

This talk is based on joint work with my colleagues A V Jayanthan and B V Raghavendra Rao.

Uniform Mixing and Quantum Walks

Chris Godsil

University of Waterloo, Canada

Let X be a graph with adjacency matrix A. A *continuous quantum walk* on X is a matrix-valued function of time $U(t)$, defined by

$$U(t) = \exp(itA).$$

The matrices $U(t)$ are unitary and so, at a fixed time t, the squares of the absolute values of the entries of a row of $U(t)$ form a probability density on the vertices of X; the properties of these densities aree of interest in quantum physics. The question we will consider is for which graphs is there a time t such that all entries of $U(t)$ have the same absolute value. In this case we say that we have *uniform mixing* on X.

This question is quite complicated. Thus uniform mixing occurs on the complete graphs K_2, K_3 and K_4, but it does not take place on K_n when $n > 4$. We know that uniform mixing does not occur on even cycles, nor on cycles of prime length p for $p > 3$; we do not know what happens on C_9, or on C_n when n is odd but not prime. If uniform mixing does occur at time t, then $U(t)$ is a generalized Hadamard matrix, Since we know the generalized Hadamard matrices that can occur in the Bose-Mesner algebra of a strongly regular graph, we can determine the strongly regular graphs that admit uniform mixing.

In my talk I will provide an introduction to what we know about this topic, and to the many open problems that remain.

Combinatorics of hyperplane arrangements: Open problems and recent progress

Christos Athanasiadis

University of Athens, Greece

We will attempt to gather some interesting problems on the combinatorics of various subarrangements of affine Weyl arrangements which have remained open for a number of years and report on recent progress by various authors on this topic.

Linial arrangements and Eulerian polynomials

Masahiko Yoshinaga

Hokkaido University, Japan

We will discuss the relationship between Linial arrangements associated to a root system and the Eulerian polynomial.

Valid orderings of a real hyperplane arrangement

Richard P. Stanley

Massachusetts Institute of Technology, USA

Given an arrangement $\mathcal{A}$ in $\mathbb{R}^n$ and a point $p \in \mathbb{R}^n$ not lying on any of the hyperplanes, a *valid ordering* of the hyperplanes (with respect to p) is obtained by choosing a directed line L through p that does not pass through the intersection of two hyperplanes, and listing the hyperplanes in the order they are crossed as we go out along L from p to ∞ and then come back from ∞ to p on the other side of L. The valid orderings correspond to the regions of another arrangement $\mathrm{vo}(\mathcal{A}, p)$, the *valid order arrangement*. We will discuss some aspects of the valid order arrangement, including its connection with the concept of Dilworth completion.

A characterization of freeness for ψ-graphical arrangements

Shuhei Tsujie

Hokkaido University, Japan

A ψ-graphical arrangement was introduced by Richard P. Stanley as a generalization of graphical arrangements. Lili Mu and Stanley characterized supersolvability for ψ-graphical arrangements and conjectured that supersolvability and freeness are equivalent for ψ-graphical arrangements. In this talk, we will verify this conjecture in terms of vertex-weighted graphs over a poset. This talk is based on joint work with Daisuke Suyama

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Divisional flags and freeness of hyperplane arrangements

Takuro Abe

Kyushu University, Japan

We introduce the concept of divisional flags of hyperplane arrangements which are defined in terms of intersection lattices. If an arrangement has a divisional flag, then it is free. In particular, the freeness of such arrangements depends only on combinatorics. We pose some problems asking the combinatorial and topological meaning of divisional flags.

Revisiting certain symmetric designs and Hadamard difference sets

Richard M. Wilson

California Institute of Technology, U.S.A.

We survey two related topics that have interested this speaker for some time. The first is the construction of symmetric designs of various parameters using finite geometries and Hadamard matrices and their generalizations. The second is the construction of Hadamard difference sets using finite geometries. In particular, we describe a variation on a construction of this author and Q. Xiang of Hadamard difference sets of order $4p^4$ from 1996.

Factorizations of cyclic groups and decompositions of a Singer orbit of a projective line

Kohei Yamada

Nagoya University, Japan

Let G be a cyclic group. If there exist subsets $A, B \subset G$ with $A + B = \lambda G$, the pair (A, B) is said to be a λ-fold factorization of G, where $A + B := \{a + b \mid a \in A, b \in B\}$. In this talk, we give a condition for the existense of a λ-fold factorization of G. Moreover, applying these results, we obtain a condition that a Singer orbit of a projective line is decomposable into λ-fold spreads. (joint work with Miwako Mishima and Masakazu Jimbo)

On cyclic grid-block designs

Xiao-Nan Lu

Nagoya University, Japan

The notion of grid-block designs originated from the experimental designs for DNA library screening, which is also known as $(K_v, K_r \times K_r)$ graph designs. In this talk, we investigate the existence and constructions of cyclic $2 \times k$ grid-block designs for odd k. From an algebraic number theoretic viewpoint, we will show that a cyclic $(p, 2 \times k, 1)$ grid-block designs holding the "cyclotomic structure" exits for an infinitely many number of prime p. Moreover, some applications for resolvable grid-block designs will be proposed. This talk is based on joint work with Junya Satoh (Nagoya University) and Masakazu Jimbo (Chubu University).

Unbiased orthogonal designs

Sho Suda

Aichi University of Education, Japan

In this talk, the notion of unbiased orthogonal designs is introduced as a generalization among unbiased Hadamard matrices, unbiased weighing matrices and quasi-unbiased weighing matrices. We provide upper bounds and several constructions for mutually unbiased orthogonal designs. As applications, mutually unbiased Bush-type Hadamard matrices and association schemes are obtained.

On tight relative t-designs in hypercubes

Hajime Tanaka

Tohoku University, Japan

Relative t-designs in hypercubes are a two-step generalization of combinatorial t-designs, allowing multiple block sizes and weights. Using the Terwilliger algebra of hypercubes, we show that relative $2e$-designs with two block sizes which are tight, i.e., attain the Fisher-type inequality, have the structure of coherent configurations. Moreover, we show that the existence of such a relative design implies that the zeros of a certain Hahn polynomial of degree e must be integers. This generalizes results of Delsarte (1973) and Ray-Chaudhuri and Wilson (1975) for tight $2e$-designs.

New upper bounds for nonbinary codes based on quadruples

Bart Litjens

University of Amsterdam, The Netherlands

In this talk we present some results on new upper bounds for the the maximum cardinality $A_q(n, d)$ of a code of length n over an alphabet with q letters and with minimum distant at least d. By symmetry of the problem, representation theory can be applied to reduce to a semidefinite programming problem with order bounded by a polynomial in n. It yields the new upper bounds $A_4(6, 3) \leq 176$, $A_4(7, 4) \leq 155$, $A_4(7, 3) \leq 596$, $A_5(7, 5) \leq 87$, $A_5(7, 4) \leq 489$ and $A_5(8, 5) \leq 425$. This talk is based on joint work with Sven Polak and Alexander Schrijver (University of Amsterdam).

Network optimization on unit disk graphs

Takuro Fukunaga

National Institute of Informatics, Japan

A unit disk graph is a reasonable model of wireless networks, and hence optimization problems motivated by applications in communication networks have been extensively studied on unit disk graph. In this talk, we introduce our recent study on the k-connected m-dominating set problem. This problem is motivated by construction of a fault-tolerant virtual backbone in a wireless ad hoc network. However, constant-approximation algorithms were known only for several restricted cases even if the given graph is a unit disk graph. We present constant-approximation algorithms for any fixed constant k such that $k \leq m$.

How to Make a Bipartite Graph DM-irreducible by Adding Edges

Yutaro Yamaguchi

University of Tokyo, Japan

The Dulmage–Mendelsohn decomposition (or the DM-decomposition for short) gives a unique partition of the vertex set of a bipartite graph reflecting the structure of all the maximum matchings therein. A bipartite graph is said to be DM-irreducible if the DM-decomposition consists of a single component, which is equivalent (under the connectivity) to the condition that every edge is contained in some perfect matching. It is not difficult to see that every complete bipartite graph is DM-irreducible, but completeness is not necessary for bipartite graphs to be so. Then, there arises a natural question: how efficiently is a given bipartite graph made DM-irreducible by adding edges? Specifically, we focus on the problem of finding a minimum number of additional edges to attain the DM-irreducibility. When the input bipartite graph is balanced (i.e., the left-side and right-side vertex sets have the same cardinality) and has a perfect matching, this problem reduces to making a directed graph strongly connected by adding edges, for which the minimum number of additional edges was characterized by Eswaran and Tarjan (1976). In this talk, we provide a solution to the general case by showing how to make an arbitrary bipartite graph DM-irreducible by adding a minimum number of edges. This talk is based on joint work with Satoru Iwata and Jun Kato (University of Tokyo).

Maximizing Monotone Submodular Functions over the Integer Lattice

Tasuku Soma

The University of Tokyo, Japan

Maximizing monotone submodular functions under a certain constraint has been intensively studied in the last decade and it is now recognized as a powerful framework for various machine learning problems. In this talk, we consider generalized monotone submodular function maximization over the integer lattice and present polynomial time approximation algorithms for various constraints. We also discuss its applications on machine learning tasks. This talk is based on joint work with Yuichi Yoshida (National Institute of Informatics, and Preferred Infrastructure, Inc., Japan).

Arborescence covering problems: structural results and algorithms

Tamás Király

Eötvös University, Budapest, Hungary

The robustness problem for minimum cost arborescences, proposed by Naoyuki Kamiyama, is the following: given a digraph with arc costs, what is the minimum number of arcs whose removal increases the minimum cost of a spanning arborescence? A polynomial-time algorithm for this problem was presented by Bernáth and Pap at IPCO 2013; since then, several extensions have been studied, including weighted versions of the problem and extensions involving multiple arborecences. In this talk I will present these new developments as well as some interesting structural properties underying the algorithmic results. The talk is based on joint work with Attila Bernáth and Gyula Pap (Eötvös University).

Discrete Convex Analysis beyond $\mathbf{Z}^n$

Hiroshi Hirai

The University of Tokyo, Japan

Discrete Convex Analysis (DCA), developed by Murota and his collaborators over past 20 years, is a theory of "convex" functions on integer lattice $\mathbf{Z}^n$, which provides a unified theoretical framework to well-solvable combinatorial optimization problems related to network flow and submodular/matroid optimization.

In this talk, we mention some recent developments to extend DCA concepts and algorithms to "convex" functions on certain graph structures beyond $\mathbf{Z}^n$ ($\sim$ grid graph), in which two new classes of discrete convex functions, *submodular functions on modular semilattices* and *L-convex functions on oriented modular graphs*, play central roles. Here a modular semilattice is a semilattice analgoue of a modular lattice, and an oriented modular graph is a kind of an amalgamation of modular lattices and semilattices. The highlights of the developments are summarized as follow:

- Our submodular function is minimizable under valued-CSP model. For special modular semilattices, our submodular functions are identical to several other submodular-type functions, such as bisubmodular, k-submodular, and α-bisubmodular functions.

- Our L-convex functions have several properties analogous to that $\mathrm{L}^\natural$-convex functions in DCA have, and coincide with $\mathrm{L}^\natural$-convex functions if the underlying graph is a grid graph. Analogous to $\mathrm{L}^\natural$-convex functions, our L-convex functions are minimized by the steepest descent algorithm (SDA), where each descent step is the minimization of a submodular function on a modular semilattice.

- The underlying structures, modular semilattices and oriented modular graphs, have rich connections to other fields of mathematics that include incidence geometries (projective and polar spaces), Euclidean building, and metric spaces of global nonpositive curvature (CAT(0) spaces). For some cases, our submodular/L-convex function is naturally extended to a function on a CAT(0) space via an analogue of the Lovász extension, and is characterized by its convexity relative to the CAT(0) metric.

- Our theory originated from the complexity classification of the multifacility location problem on graph Γ, which asks to minimize a weighted sum of distances $d_\Gamma(x_i, x_j)$, $d_\Gamma(x_i, v)$ $(1 \leq i, j \leq n, v \in V(\Gamma))$ over $(x_1, x_2, \ldots, x_n) \in (V(\Gamma))^n$. If Γ is orientable modular, the multifacility location problem on Γ is an L-convex function minimization, and polynomially solvable. This establishes the desired complexity classification, since the problem on other graphs is known to be NP-hard. This dichotomy theorem is a major achievement in the literature.

- Dual objectives arising from classes of well-behaved multicommodity flow problems are submodular or L-convex in suitable sense. This fact may be viewed as a far-reaching generalization of a common sense in combinatorial optimization: the min-cut function, the dual objective of the max-flow problem, is submodular. Moreover, DCA-oriented algorithm design (based on SDA) leads to efficient combinatorial polynomial time algorithms for some classes of minimum-cost and node-capacitated multiflow problems, where such algorithms were not known so far.

Reconfiguring graph colourings

Gary MacGillivray

University of Victoria, Canada

Let H be a graph and k be a positive integer. The *k-colouring graph of H* has as its vertices the proper k-colourings of H, any two of which are joined by an edge if and only if they agree on all but one vertex of H. When this graph is connected, any given k-colouring can be reconfigured into any other via a sequence of recolourings which each change the colour of exactly one vertex. When it is Hamiltonian, there is a cyclic list that contains all of the k-colourings of H, and consecutive elements of the list differ in the colour of exactly one vertex. In this talk we survey some results on k-colouring graphs, and related graphs which are defined similarly for other colourings.

Codes from neighborhood designs of the graphs $GP(q, \frac{q-1}{2})$ with q odd

Jirapha Limbupasiriporn

Silpakorn University, Thailand

This talk will concern the neighborhood design of the generalized Paley graph $GP(q, k)$ of a finite field $\mathbb{F}_q$ of order q and the corresponding p-ary code. The graph $GP(q, k)$ has vertex set $\mathbb{F}_q$ and adjacency defined by two vertices being adjacent if their difference is in a multiplicative subgroup of $\mathbb{F}_q$ of order $\frac{q-1}{k}$ where k is a divisor of $q-1$ such that $k \geq 2$ and if q is odd then $\frac{q-1}{k}$ is even. The talk will concentrate mainly on the case where q is odd and $k = \frac{q-1}{2}$ and will cover determining the main parameters of the code of the neighborhood design of the graph $GP(q, k)$ and their duals including bases of minimum-weight vectors.

On color-degree conditions for long rainbow paths

Roman Čada

University of West Bohemia, Czech Republic

A rainbow path is a path having all edges colored with mutually distinct colors. In the talk we summarize and present some necessary conditions based on color degrees for the existence of long rainbow paths.

Chromatic number of P_5-free graphs: χ-binding functions

Ingo Schiermeyer

Technische Universität Bergakademie Freiberg, Germany

In this talk we study the chromatic number of P_5-free graphs. Gyárfas has shown the following

Theorem Let G be a P_k-free graph for $k \geq 4$ with clique number $\omega(G) \geq 2$. Then $\chi(G) \leq (k-1)^{\omega(G)-1}$.

We will show that there is a polynomial χ-binding function for several subclasses of P_5-free graphs. Our main result is the following.

Theorem Let G be a P_5-free graph of order n and clique number $\omega(G)$, and let Gem^+ denote the graph $(K_1 + (K_1 \cup P_4))$. If G is (i) $Claw$-free or (ii) Paw-free or (iii) $Diamond$-free or (iv) $Dart$-free or (v) $Cricket$-free or (vi) Gem-free or (vii) Gem^+-free, then $\chi(G) \leq \omega^2(G)$.

We also show that the class of $(P_5, windmill)$-free graphs has a polynomial χ-binding function.

On Weighing Matrices

Giora Dula

Netanya Academic College, Israel

In this talk we present how the new $W(23,16)$ was found. The process of finding any new weighing matrix W is divided into two stages, finding W mod 2 and mod Z, following "on inequivalent weighing matrices" (Chan Rodger Seberry) 1986 and "on the finite geometry of $W(23,16)$" Goldberger 2015 This talk is based on joint work with Assaf Goldberger (TA University TA Israel) and Yossi Strassler (Dan Yishai resorts Israel).

Combinatorial Constructions of Optimal $(m, n, 4, 2)$ Optical Orthogonal Signature Pattern Codes

Jingyuan Chen

Soochow University, China

Optical orthogonal signature pattern codes (OOSPCs) play an important role in a novel type of optical code-division multiple-access (CDMA) network for 2-dimensional image transmission. There is a one-to-one correspondence between an (m, n, w, λ)-OOSPC and a $(\lambda + 1)$-$(mn, w, 1)$ packing design admitting an automorphism group isomorphic to $\mathbb{Z}_m \times \mathbb{Z}_n$. In 2010, Sawa gave the first infinite class of $(m, n, 4, 2)$-OOSPCs by using S-cyclic Steiner quadruple systems. In this talk, we present some results of Optimal $(m, n, 4, 2)$ Optical Orthogonal Signature Pattern Codes. These results are obtained by using various combinatorial designs such as strictly $\mathbb{Z}_m \times \mathbb{Z}_n$-invariant s-fan designs, strictly $\mathbb{Z}_m \times \mathbb{Z}_n$-invariant G-designs and rotational Steiner quadruple systems. As a consequence, our new constructions yield more infinite families of optimal $(m, n, 4, 2)$-OOSPCs. Especially, we shall see that in some cases an optimal $(m, n, 4, 2)$-OOSPC can not achieve the Johnson bound. This talk is based on joint work with Yun Li (Soochow University) and Lijun Ji (Soochow University).

Forbidden subgraphs and weak locally connected graphs

Liming Xiong

Beijing Institute of Technology, P.R. China

In this talk, we present a relation between forbidden subgraphs and weak locally connected graphs G with some properties, such as the existence of spanning eulerian subgraphs(the graph G is called *supereulerian*), 2-factors, hamiltonian cycles. In particular, we show that: Let H be a connected graph of order at least three and G be a connected graph. Then

- every 2-connected H-free graph of minimum degree at least three is supereulerian if, and only if H is a connected subgraph of P_5.
- every N_2-locally connected H-free graph G of order at least three with $\delta(G) \geq 2$ implies that G has a 2-factor if, and only if H is either $K_{1,2}$ or $K_{1,3}$.
- if every 3-connected, N_2-locally connected H-free graph of order at least three implies that G is hamiltonian, then G is one of the following: $K_{1,2}$, $K_{1,3}, K_{1,4}$.

Where a graph G is *N_2-locally-connected* if for any $w \in V(G)$ it holds that the subgraph induced by the set of edges uv, such that either u or v is adjacent to w is connected.

This talk is based on joint work with Akira Saito (Nihon University).

Domination number of outer annulus triangulations

Toshiki Abe

Yokohama National University, Japan

It is conjectured that every maximal planar graph with n vertices has domination number at most $\frac{n}{4}$ if n is large. Tokunaga gave a result for domination number of maximal outerplanar graphs, using an elegant graph coloring method. By a similar method, we give the best possible evaluation for domination number of an *annulus triangulation*, which is a 2-connected plane graph with all faces triangular but exactly two disjoint special faces f_1 and f_2 such that every vertex is contained in the boundary cycle of f_1 or f_2.

Bounded growth functions: Gray codes and exhaustive generation

Vincent Vajnovszki

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Restricted growth functions are integer sequences $a_1a_2\dots a_n$ with $a_1 = 0$ and $0 \leq a_{i+1} \leq 1+\max\{a_j\}_{1\leq j\leq i}$, for $1 \leq i < n$. They code a large family of combinatorial objects, among them set partitions, and are counted by Bell numbers. When the additional constraint $\max\{a_j\}_{1\leq j\leq n} = b$ (resp. $\max\{a_j\}_{1\leq j\leq n} \leq b$) is imposed, for some $b > 0$, then the corresponding integer sequences are called bounded growth functions and code set partitions into b (rest. at most b) blocks, and are counted by Stirling numbers of the second kind. We present order relation based Gray codes for bounded growth functions; the corresponding efficient generating algorithms are also discussed. This talk is based on joint work with Ahmad Sabri (Gunadarma University, Jakarta, Indonesia).

On Terwilliger algebra of Lee association schemes over $\mathbb{Z}_4$

John Vincent S. Morales

Tohoku University, Japan

Let $F = \{0, 1, 2, 3\}$ and $K = \{K_0, K_1, K_2\}$ such that $(x, y) \in K_i$ iff $x - y \equiv \pm i \pmod 4$. The Lee association scheme $L(n, 4)$ over $\mathbb{Z}_4$ which is the nth extension of the association scheme (F, K) serves as a framework for studying codes under Lee distance. Let $\mathcal{T}$ denote the Terwilliger algebra of $L(n, 4)$ with respect to $(0, 0, \ldots, 0)$. We determine the irreducible $\mathcal{T}$-modules and show every irreducible $\mathcal{T}$-module has the structure of an irreducible $\mathfrak{sl}_3(\mathbb{C})$-module. We show $\mathcal{T}$ is generated by the homomorphic image of universal enveloping algebra $\mathcal{U}(\mathfrak{sl}_3(\mathbb{C}))$ and $Z(\mathcal{T})$. Finally, we discuss some applications to $\mathbb{Z}_4$-codes. This is based on joint work with Hajime Tanaka (Tohoku University)

Supereulerian Digraphs

Hong-Jian Lai

West Virginia University, USA

A strong digraph is eulerian if at every vertex, the in-degree is the same as the out-degree. A digraph is supereulerian if it contains a spanning eulerian subdigraph. The supereulerian digraph problem is to seek characterization of supereulerian digraphs. In this talk we present some of the recent progresses on sufficient and necessary conditions for a digraph to be supereulerian, including efforts towards the Bang-Jensen and Thommassé conjecture that a digraph is supereulerian if its arc-strong connectivity is not less than its independence number. We also investigate conditions to assure supereulerian digraph products. This talk is based on joint work with Mansour J. Algefari and Khalid A. Alsatami (Qassim University, KSA), and Juan Liu and Xindong Zhang (Xinjian Normal University, CHN).

A Dichotomy Theorem for Circular Colouring Reconfiguration

Richard Brewster

Thompson Rivers University, Canada

The "reconfiguration problem" for circular colourings asks, given two (p, q)-colourings f and g of a graph G, is it possible to transform f into g by changing the colour of one vertex at a time such that every intermediate mapping is a (p, q)-colouring? We show that this problem can be solved in polynomial time for $2 \leq p/q < 4$ and is PSPACE-complete for $p/q \geq 4$. This generalizes a known dichotomy theorem for reconfiguring classical graph colourings. Joint with Sean McGuinness (Thompson Rivers University), Ben Moore (Simon Fraser University) and Jon Noel (Oxford University).

On Permutation Arrays for Hamming Distance: Improving MOLS Bounds

Ivan H. Sudborough

University of Texas at Dallas, USA

We present results on $M(n, d)$, the size of the largest permutation array on Z_n with Hamming distance d. Permutations ρ and σ have Hamming distance d, denoted by $hd(\rho, \sigma) = d$, when exactly d integers x satisfy $\rho(x) \neq \sigma(x)$. Array H has Hamming distance d if, for every pair of permutations ρ and σ in H, $hd(\rho, \sigma) \geq d$. We describe a *partition and extension* method, and variations, giving improved lower bounds, specifically for $M(n, n-1)$ and $M(n, n-2)$. This improves previous bounds for $M(n, n-1)$ using MOLS. (Joint work with Sergey Bereg and Linda Morales, both at the University of Texas at Dallas.)

Coloring and List Coloring of the Squares of Graphs

Boram Park

Ajou University, Korea

The square G^2 of a graph G is the graph with the vertex set $V(G)$ such that two vertices u and v are adjacent in G^2 if and only if the distance between u and v in G is at most two. A graph G is called chromatic-choosable if $\chi_\ell(G) = \chi(G)$, where $\chi(G)$ and $\chi_\ell(G)$ are the chromatic number and the list chromatic number of G, respectively. It is an interesting problem to find graphs that are chromatic-choosable. Kostochka and Woodall (2001) conjectured that the square of a graph is chromatic-choosable, called List Square Coloring Conjecture.

In this talk, we present several recent results on coloring and list coloring of the squares of graphs, related to List Square Coloring Conjecture. This talk is based on joint work with Seog-Jin Kim (Konkuk University).

Maximal m-distance sets containing the representation of the Hamming graph $H(n, m)$

Hiroshi Nozaki

Aichi University of Education, Japan

A set X in the Euclidean space $\mathbb{R}^d$ is called an *m-distance set* if the set of Euclidean distances between two distinct points in X has size m. An m-distance set X in $\mathbb{R}^d$ is said to be *maximal* if there does not exist a vector $\mathbf{x}$ in $\mathbb{R}^d$ such that the union of X and $\{\mathbf{x}\}$ still has only m distances. In this talk, we deal with the maximal m-distance sets which contain the Euclidean representation of the Hamming graph $H(n, m)$. The Euclidean representation of $H(n, m)$ is an m-distance set in $\mathbb{R}^{m(n-1)}$.

A Faster Algorithm for Computing Tutte Polynomials of Lattice Path Matroids

Jacob Turner

University of Amsterdam, Netherlands

In this talk we present a new algorithm for computing the Tutte polymomial for lattice path matroids. Lattice path matroids are a very well behaved type of matroid that arises in many different areas. It was known previously that computing and evaluating its Tutte polynomial could be achieved in time polynomial in the size of the ground set. We discuss the our new techniques for improving the previously known algorithms. Joint work with Jason Morton (Penn State).

Generating theorem of even triangulation on the Klein bottle

Yoshihiro Asayama

Yokohama National University, Japan

We define two reductions a 4-contraction and a twin-contraction for even triangulations on a surface. It is well known that these reductions preserve some property of graphs. The complete lists of minimal even triangulations for the sphere, the projective plane and the torus with respect to these reductions have already determined. In this talk we present the complete list of minimal even triangulations of the Klein bottle, and we discuss applications. This talk is joint work with N. Matsumoto (Seikei Univ.) and A. Nakamoto (Yokohama National Univ.).

A Matrix-Weighted Zeta Function of a Graph

Iwao Sato

Oyama National College of Technology, Japan

We define a matrix-weighted L-function of a graph G, and give a determinant expression of it. As a corollary, we present a decomposition formula for the matrix-weighted zeta function of a regular covering of G by a product of matrix-weighted L-functions of G. This talk is based on joint work with Hideo Mitsuhashi (Utsunomiya University) and Hideaki Morita (Muroran Institute of Technology).

Spherical designs of some harmonic indices

Kyoung-Tark Kim

Shanghai Jiao Tong University, China

In this talk we present our study of spherical designs of harmonic indices. We first develop a linear programming to obtain a Fisher-type inequality of the size of a design of harmonic indices. Next we define a 'tight' object as one which attains the bound of this inequality. The main investigation is our study in the non-existence of such tight designs. This talk is based on joint work with Eiichi Bannai (Shanghai Jiao Tong University), Etsuko Bannai, Wei-Hsuan Yu (Michigan State University), and Yan Zhu (Shanghai Jiao Tong University).

On Covering Numbers of of Matroids

Keisuke Shiromoto

Kumamoto University, Japan

The *covering number* of a matroid M on a finite set E, denoted by $\alpha(M)$, is defined by the minimum size of a set of cocircuits of M whose union is E. The covering number of a matroid is strongly related to the critical exponent of a representable matroid over a finite field. In this talk, we present a bound on the covering number of a matroid. And we give a construction of matroids which attain the bound. This talk is a part of joint work with Thomas Britz (University of New South Wales).

Covering projective planar graphs with forests

Raiji Mukae

National Institute of Technology, Miyakonojo College, Japan

It is known that all planar graphs and all projective planar graphs have an edge partition into three forests by Nash-Williams Theorem. In 2009, Goncalves proved that every planar graph has an edge partition into three forests, one having maximum degree at most 4. In this talk, we prove that every projective planar graph has an edge partition into three forests, one having maximum degree at most 4.

This talk is based on joint work with Kenta Ozeki(NII), Terukazu Sano(National Institute of Technology, Kisarazu College) and Ryuji Tazume(National Institute of Technology, Miyakonojo College).

Quaternionic quantum walks and zeta functions of graphs

Hideo Mitsuhashi

Utsunomiya University, Japan

In this talk we define discrete-time quaternionic quantum walks on graphs which can be viewed as a quaternionic extension of Grover walks on graphs. We explain the unitary condition for the transition matrix of the quaternionic quantum walk, and the relationship between the right spectra of the transition matrices and zeta functions of graphs. This talk is based on joint work with Norio Konno (Yokohama National University) and Iwao Sato (Oyama National College of Technology).

Relative t-designs in binary Hamming association schemes

Yan Zhu

Shanghai Jiao Tong University, China

In this talk we present some results on relative t-designs in binary Hamming association schemes $H(n,2)$. The concept of relative t-design in a Q-polynomial association scheme was defined by Delsarte in 1977, and we call it tight if it satisfies the Fisher type lower bound. In this talk, we introduce an equivalent definition given by Bannai-Bannai in 2012. We consider the Fisher type lower bound and the classification problems of tight relative t-designs. A relative t-design in binary Hamming association schemes $H(n,2)$ is equivalent to a weighted regular t-wise balanced design. We mainly generalize the result of Kageyama on regular t-wise balanced design on two shells in $H(n,2)$. We prove that if the weight function is constant on each shell of a relative t-design on p shells then the subset in each shell must be a combinatorial $(t+1-p)$-design. For $t=3,4,5$, we discuss the existence problem of tight relative t-designs on two shells in $H(n,2)$ and obtain many new examples.
This talk is based on joint work with Eiichi Bannai (Shanghai Jiao Tong University) and Etsuko Bannai (retired from Kyushu University).

Catalan-like numbers and Hankel determinants

Lili Mu

Dalian University of Technology, China

Let $(a_0, a_1, a_2, \ldots)$ be the sequence of Catalan-like numbers. In this talk we present some results on the evaluation of Hankel determinants of the shifted sequence $(0, a_0, a_1, \ldots)$. As an application, we settle Barry's three conjectures about Hankel determinant evaluations of certain sequences in a unified approach. We also evaluate Hankel determinants $\det[aa_{i+j} + ba_{i+j+1}]_{0\le i,j\le n}$ and $\det[aa_{i+j+1} + ba_{i+j+2}]_{0\le i,j\le n}$ for arbitrary coefficients a and b. Our results unify many known results of Hankel determinant evaluation for classic combinatorial counting coefficients. This talk is based on joint work with Yi Wang (Dalian University of Technology).

Hamiltonian Properties of Polyhedra with Few 3-Cuts

Carol T. Zamfirescu

Ghent University, Belgium

Thomas and Yu showed that in every 4-connected planar graph the deletion of at most two vertices yields a hamiltonian graph. From this one could deduce that every polyhedron with at most two 3-cuts is hamiltonian. Using a different approach, we show that a polyhedron with at most three 3-cuts is hamiltonian. We also briefly survey work on hamiltonian properties of polyhedra, focussing on those with few 3-cuts. This talk is based on joint work with Gunnar Brinkmann (Ghent University) and Brendan D. McKay (Australian National University).

Error correcting code from induced subgraphs of a complete graph K_n

Sul-young Choi

Le Moyne College, USA

Consider the edge space of a complete graph on n vertices K_n. Let $\mathbf{C}$ be the subspace generated by the n induced subgraphs with $(n-1)$ vertices. If a vector $\mathbf{v}$ in $\mathbf{C}$ is a sum of even (or odd) number of generators of $\mathbf{C}$, $\mathbf{v}$ represents the edges of a complete bipartite graph $K(V_1, V_2)$ (or the edges of two disjoint complete subgraphs $K(V_1)$ and $K(V_2)$) where V_1 is the intersection of vertices of the induced subgraphs corresponding to the generators and $V_2 = V(K_n) - V_1$. We show that $\mathbf{C}$ is an $(n(n-1)/2, n, n-1)$ error correcting code when n is odd, and an $(n(n-1)/2, n-1, 2(n-2))$ error correcting code when n is even. This talk is based on joint work with Puhua Guan (University of Puerto Rico, Rio Piedras, Puerto Rico).

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