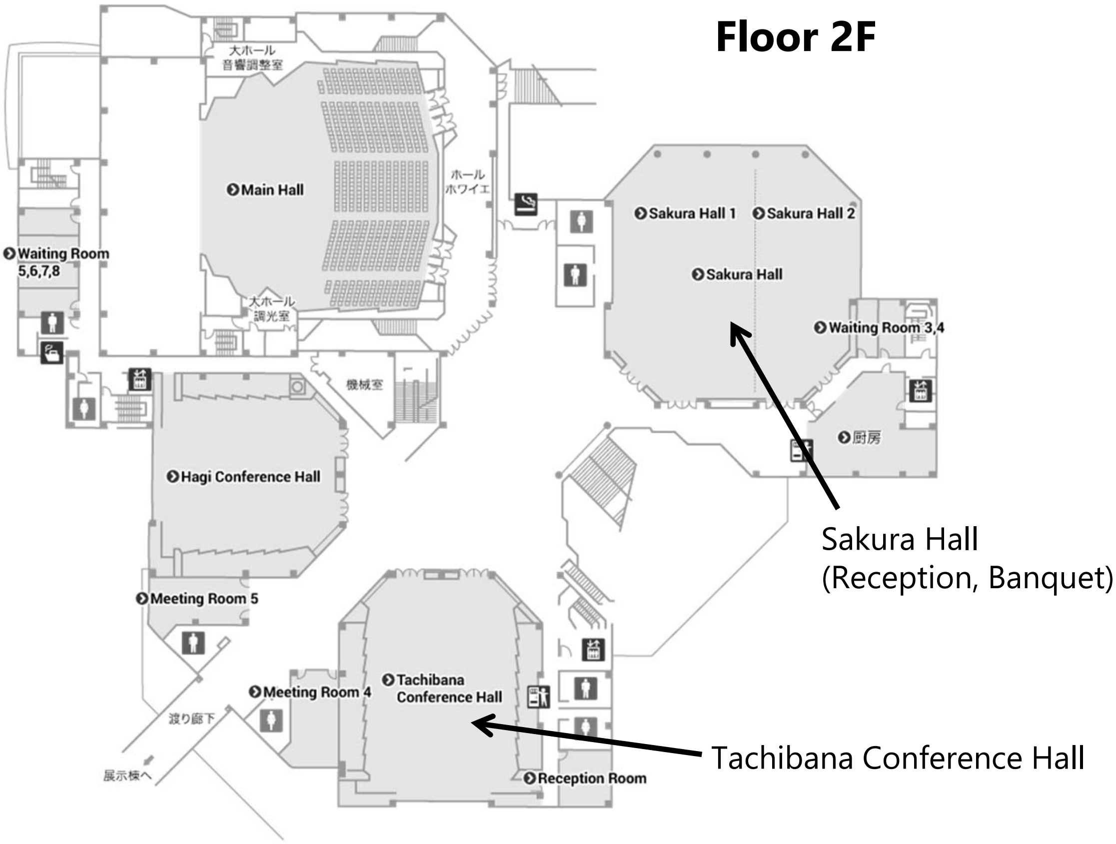
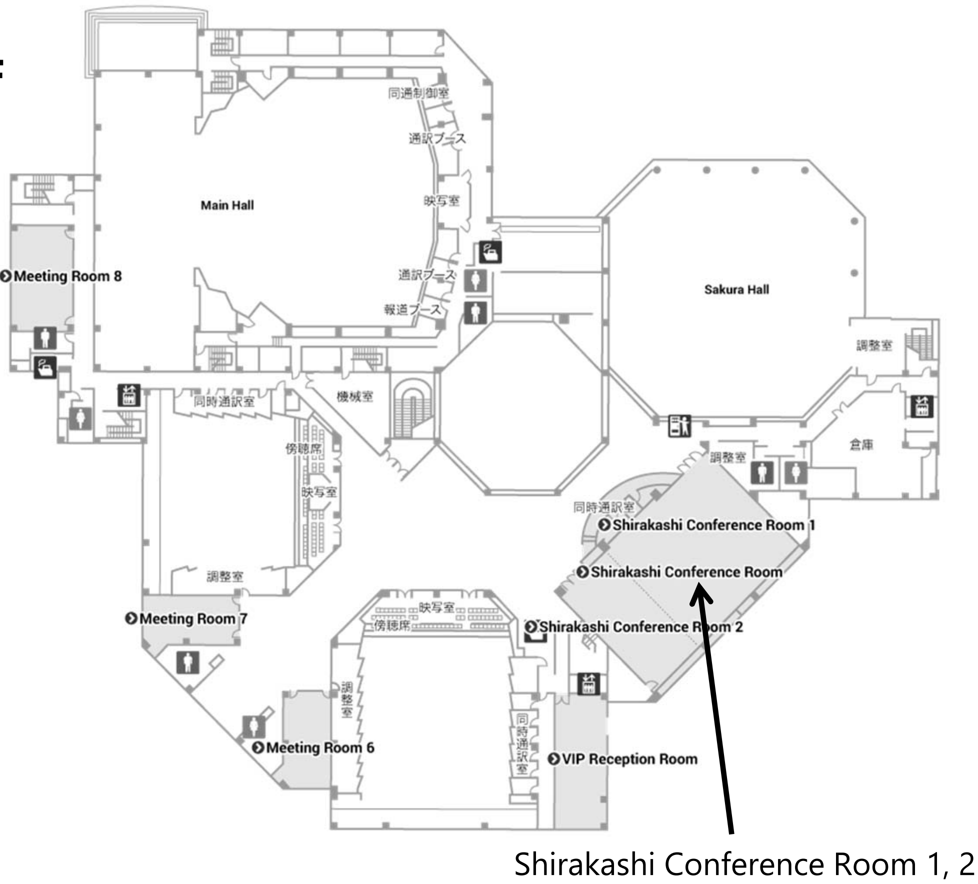
Conference Venue Map

Floor 2F



Floor 3F



Program (Day 1 – May 20 (Sun.))

Plenary Talk: Tachibana Conference Hall (2F)
Contributed Talk: a) Tachibana Conference Hall (2F) b) Shirakashi Conference Room 1 (3F)
Registration/Information Desk is open from 12:00 to 18:00

13:20

Opening Remarks at Tachibana Conference Hall (2F)

13:30

Disjoint Cycles and Equitable Colorings in Graphs
Elyse Yeager (University of British Columbia, Canada)

14:30

Coffee Break

15:00

a) *Adjacency properties of graphs and related results*
Shohei Satake (Kobe University, Japan)

b) *Binary linear complementary dual codes*
Ken Saito (Tohoku University, Japan)

15:20

15:25

a) *Results on Sigma Colorings of Planar Graphs*
Hsin-Hao Lai (National Kaohsiung Normal University, Taiwan)

b) *On a relationship between X-codes and separating parity-check matrices*
Yu Tsunoda (Chiba University, Japan)

15:45

15:50

a) *A Closed Knight's Tour Problem on the* $(5, n, 1)$*-Tube*
Nathaphat Loykaew (Ramkhumhaeng University, Thailand)

b) *Constructing new linear codes over the field of order five*
Yuto Inoue (Osaka Prefecture University, Japan)

16:10

16:15

a) *The Number of Squares Required* k *with the* $(1, 3)-$ *Knight's Move*
Ratree Theprod (Ramkhumhaeng University, Thailand)

b) *Nonexistence of some Griesmer codes over the field of order five*
Wataru Kuranaka (Osaka Prefecture University, Japan)

16:35

Coffee Break

16:50

a) *Embeddings of regular digraphs on surfaces*
Gen Kawatani (Tokyo University of Science, Japan)

b) *Extendability of quaternary linear codes of dimension three*
Makoto Shirouzu (Osaka Prefecture University, Japan)

17:10

17:15

a) Q_4*-irreducible even triangulations of the projective plane*
Jun Hasegawa (Niigata University, Japan)

b) *A Systematic Construction of High Index Covering Arrays*
Frederick Kin Hing Phoa (Academia Sinica, Taiwan)

17:35

17:40

a) *Homogeneity of maps on closed surfaces*
Seiya Negami (Yokohama National University, Japan)

b) *Some existence of perpendicular multi-arrays*
Kazuki Matsubara (Chuo Gakuin University, Japan)

18:00

18:30

Welcome Reception at Sakura Hall

20:00

Program (Day 2 – May 21 (Mon.))

Plenary Talk: Tachibana Conference Hall (2F)
Contributed Talk: a) Tachibana Conference Hall (2F) b) Shirakashi Conference Room 1 (3F)
Registration/Information Desk is open from 9:10 to 18:10

9:40

Polynomial ideals associated to combinatorial objects
William J. Martin (Worcester Polytechnic Institute, USA)

10:40

Coffee Break

11:00

a) *Degree conditions for partitioning graphs into chorded cycles*
Shuya Chiba (Kumamoto University, Japan)

b) *Balancedly splittable Hadamard matrices*
Sho Suda (Aichi University of Education, Japan)

11:20

11:25

a) *Degree sum conditions for bipartite graphs to have S-path-systems*
Takamasa Yashima (Keio University, Japan)

b) *Relative t-designs on one shell of Johnson association schemes*
Yan Zhu (Shanghai University, China)

11:45

11:50

a) *Fault-Tolerant Vertex-Pancyclicity of Crossed Cubes CQ_n*
Xirong Xu (Dalian University of Technology, China)

b) *Complex Hadamard matrices attached to 3-class commutative nonsymmetric association schemes*
Takuya Ikuta (Kobe Gakuin University, Japan)

12:10

Lunch

13:40

a) *Re-embedding structures of 3-connected 3-regular planar graphs into nonorientable closed surfaces*
Kengo Enami (Yokohama National University, Japan)

b) *Great antipodal sets on unitary groups and Hamming graphs*
Hirotake Kurihara (National Institute of Technology, Kitakyushu College, Japan)

14:00

14:05

a) 1-*Embeddability of complete multipartite graphs on the projective plane*
Hikari Shibuya (Niigata University, Japan)

b) *Enumerating partial Latin rectangles*
Rebecca J. Stones (Nankai University, China)

14:25

14:30

a) *Exceptional balanced triangulations of surfaces*
Yusuke Suzuki (Niigata University, Japan)

b) *Totally Symmetric Latin Squares with Trivial Autotopism Groups*
Trent G. Marbach (Nankai University, China)

14:50

Coffee Break

15:05

a) *On the partial order competition dimension and the chromatic number of a graph*
Yoshio Sano (University of Tsukuba, Japan)

b) *Skew hook formula for d-complete posets*
Soichi Okada (Nagoya University, Japan)

15:25

15:30

a) *The Size Ramsey Number Involving* P_3
Denny Riama Silaban (Universitas Indonesia, Indonesia)

b) *A nice partition function for reverse plane partitions derived from a discrete integrable system*
Shuhei Kamioka (Kyoto University, Japan)

15:50

15:55

a) *Unique realisations of graphs*
Katie Clinch (University of Tokyo, Japan)

b) *Signed Mahonian identities on permutations*
Sen-Peng Eu (National Taiwan Normal University, Taiwan)

16:15

16:20

a) *A new Bartholdi zeta function for a graph*
Lin Zhu (Shanghai Jiao Tong University, China)

b) *On enumeration of restricted permutations of genus zero*
Tung-Shan Fu (National Pingtung University, Taiwan)

16:40

Coffee Break

16:55

a) *The Set Chromatic Number of Circulant Graphs* $C_n(a, b)$
Bryan Ceasar L. Felipe (Ateneo de Manila University, Philippines)

b) *Using Partition and Extension to Build Large Permutation Arrays for Hamming Distances*
Hal Sudborough (University of Texas at Dallas, USA)

17:15

17:20

a) *The Sigma Chromatic Number of Corona of Cycles or Paths with Complete Graphs*
Maria Czarina T. Lagura (University of Santo Tomas-Senior High School, Philippines)

b) *The Allocation of Array Storage in Parallel Memory Modules*
Chih-Hung Yen (National Chiayi University, Taiwan, R.O.C.)

17:40

17:45

a) *On the Sigma Value and Range of the Join of a Finite Number of Paths*
Marie Cris A. Bulay-og (Ateneo de Manila University, Philippines)

b) *Explicit Constructions for Coded Caching Schemes*
Minquan Cheng (Guangxi Normal University, China)

18:05

Program (Day 3 – May 22 (Tue.))

Plenary Talk: Tachibana Conference Hall (2F)
Contributed Talk: a) Tachibana Conference Hall (2F) b) Shirakashi Conference Room 1 (3F)
Registration/Information Desk is open from 9:10 to 12:10

9:40

Combinatorial Reciprocity Theorems
Matthias Beck (San Francisco State University, USA)

10:40

Coffee Break

11:00

a) *On some topological upper bounds of the apex trees*
Sarfraz Ahmad (COMSATS Institute of Information Technology, Pakistan)

b) *Regular unimodular triangulations of dilated empty simplices and Gröbner basis*
Akihiro Higashitani (Kyoto Sangyo University, Japan)

11:20

11:25

a) *Network model for the spreading of Influenza virus*
Puntani Pongsumpun (King Mongkut's Institute of Technology Ladkrabang, Thai)

b) *The Converse of Pentagonal Subdivision*
Min Yan (Hong Kong University of Science and Technology, Hong Kong)

11:45

11:50

a) *On the Optical and Forwarding Indices of Graphs*
Yuan-Hsun Lo (Xiamen University, China)

b) *Almost Equilateral Pentagonal Tilings of the Sphere*
Hoi Ping LUK (The Hong Kong University of Science & Technology, Hong Kong)

12:10

Lunch

12:50

Excursion to Matsushima

18:00

18:30

Banquet at Sakura Hall

20:30

Program (Day 4 – May 23 (Wed.))

Plenary Talk: Tachibana Conference Hall (2F)
Contributed talk and Mini Symposium: a) Tachibana Conference Hall (2F)
b) Shirakashi Conference Room 1 (3F) c) Shirakashi Conference Room 2 (3F)
Registration/Information Desk is open from 9:10 to 18:10

9:40

The complete classification of empty lattice 4-simplices
Francisco Santos (Universidad de Cantabria, Spain)

10:40

Coffee Break

11:00

a) *An algorithm for finding triad colorings of triangulations on closed surfaces*
Yumiko Ohno (Yokohama National University, Japan)

b) *Reflexive polytopes arising from edge polytopes*
Akiyoshi Tsuchiya (Osaka University, Japan)

11:20

11:25

a) *Stable embeddings of graphs on closed surfaces with minimum length*
Naoki Mochizuki (Yokohama National University, Japan)

b) *The combinatorics of hyperplane arrangements and the geometry of hypertoric varieties*
Takahiro Nagaoka (Kyoto University, Japan)

11:45

11:50

a) *Geometric quadrangulations of a polygon*
Atsuhiro Nakamoto (Yokohama National University, Japan)

b) *Antiadjacency Spectral Property of Regular Graph*
Kiki Ariyanti Sugeng (Universitas Indonesia, Indonesia)

12:10

Photo Session

12:30

Lunch

14:00

a) Mini Symposium : Combinatorics on Convex Polytopes
(Organizers: Akihiro Higashitani and Satoshi Murai)

14:00-14:45 *Toric Fano varieties associated to graph cubeahedra*
Yusuke Suyama (Osaka University, Japan)

15:00-15:45 *Classifications of lattice polytopes by their volume*
Gabriele Balletti (Stockholm University, Sweden)

16:00-16:45 *On Gelfand-Cetlin polytopes*
Yunhyung Cho (Sungkyunkwan University, Republic of Korea)

17:00-17:45 *Classification of Ehrhart polynomials (in particular, of zonotopes)*
Matthias Beck (San Francisco State University, USA)

b) Mini Symposium : Graph Colouring and Forbidden Subgraphs
(Organizer: Ingo Schiermeyer)

14:00-14:30 *Gallai Ramsey number for K_4*
Ingo Schiermeyer (Technische Universität Bergakademie Freiberg, Germany)

14:30-15:00 *Unavoidable trees in a graph with large star chromatic number*
Boram Park (Ajou University, Korea)

15:10-15:40 *Rainbow connection parameters and forbidden subgraphs*
Xueliang Li (Nankai University, China)

15:40-16:10 *On a sufficient condition for a graph with boxicity at most its chromatic number*
Akira Kamibeppu (Shimane University, Japan)

16:20-16:50 *3-dynamic colorings for triangulations on the closed surfaces.*
Yoshihiro Asayama (Yokohama National University, Japan)

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

14:00-14:45 [Special Talk] *On recent progress on graphs with smallest eigenvalue at least* -3
Jack Koolen (University of Science and Technology of China, Dutch)

15:00-15:20 *Maximizing the order of regular bipartite graphs for given valency and second eigenvalue.*
Hiroshi Nozaki (Aichi University of Education, Japan)

15:25-15:45 *Edge-regular graphs and regular cliques*
Gary Greaves (Nanyang Technological University, Singapore)

15:50-16:10 *The position of classified edges due to the change in multiplicity of an eigenvalue in a tree*
Kenji Toyonaga (National Institute of Technology, Kitakyushu College, Japan)

16:25-16:45 *Recent results on Q-polynomial association schemes*
William J. Martin (Worcester Polytechnic Institute, USA)

16:50-17:10 *A diagram associated with the subconstituent algebra of a distance-regular graph*
Supalak Sumalroj (Silpakorn University, Thailand)

17:15-17:35 *Periodicities of Grover walks on distance-regular graphs*
Yusuke Yoshie (Tohoku University, Japan)

17:40-18:00 *Spectral analysis on the positive support of n-th power of Grover walk on a large girth graph*
Etsuo Segawa (Tohoku University, Japan)

Program (Day 5 – May 24 (Thu.))

Contributed talk and Mini Symposium: a) Tachibana Conference Hall (2F)
b) Shirakashi Conference Room 1 (3F) c) Shirakashi Conference Room 2 (3F)
Registration/Information Desk is open from 9:10 to 18:10

9:30

a) *Number of 4-contractible edges in 4-connected graphs*
Yoshimi Egawa (Tokyo University of Science, Japan)

b) *On a cluttered ordering for a bipartite graph*
Tomoko Adachi (Toho University, Japan)

c) *Domination in prism graphs*
Monika Rosicka (University of Gdańsk, Poland)

9:50

9:55

a) *Rainbow and Properly Colored Spanning Subgraphs*
Yangyang Cheng (Shandong University, China)

b) *On mutually* 3*-orthogonal diagonal cubes*
Xiao-Nan Lu (Tokyo University of Science, Japan)

c) *On Open Neighborhood Locating-Dominating Set of Mycielski Graphs*
Suhadi Wido Saputro (Bandung Institute of Technology, Indonesia)

10:15

10:20

a) *Some Rainbow Turán Problems for Hypergraphs*
Qiancheng Ouyang (Shandong University, P. R. China)

b) *Codes with Rank-Metric and Matroids*
Keisuke Shiromoto (Kumamoto University, Japan)

c) *Forbidden subgraphs for constant domination number*
Michitaka Furuya (Kitasato University, Japan)

10:40

Coffee Break

11:00

a) *The solution-attractor theory of local search system: the traveling salesmen problem case*
Weiqi Li (University of Michigan-Flint, United States)

b) *On p-frame potential of random point configurations on the sphere*
Masatake Hirao (Aichi Prefectural University, Japan)

11:20

11:25

a) *On the Recognition of Unit Grid Intersection Graphs*
Satoshi Tayu (Tokyo Institute of Technology, Japan)

b) *Spherical embeddings of symmetric association schemes*
Da Zhao (Shanghai Jiao Tong University, China)

11:45

11:50

a) *The Nature Diagnosability of Bubble-sort Star Graphs under the PMC Model and MM^* Model*
Mujiangshan Wang (The University of Newcastle, China, Australia)

b) *Classification problem of certain spherical embeddings of strongly regular graphs*
Eiichi Bannai (Japan)

12:10

Lunch

14:00

a) Mini Symposium : Combinatorial Optimization and Related Topics
(Organizers: Shin-ichi Tanigawa and Kenjiro Takazawa)

14:00-14:40 *A Polynomial Time Algorithm to Compute Geodesics in CAT(0) Cubical Complexes*
Koyo Hayashi (University of Tokyo, Japan)

14:40-15:20 *Solving Feedback Vertex Set via Half-Integral Relaxation*
Yoichi Iwata (National Institute of Informatics, Japan)

15:35-16:15 *Cheeger Inequalities for Submodular Transformations*
Yuichi Yoshida (National Institute of Informatics, Japan)

16:15-16:55 *Complexity of the Multi-Service Center Problem*
Naonori Kakimura (Keio University, Japan)

17:10-17:50 *Rectangular Matrix Multiplication: Overview of Recent Progress*
François Le Gall (Kyoto University, Japan)

b) Mini Symposium : Finite Combinatorics and Infinite Combinatorics
(Organizers: Masanori Sawa, Hirotaka Kikyo, Shohei Satake and Shunsuke Okabe)

14:00-14:30 *A graph-theoretic construction of Dihedral quadruple systems and its countable analogue*
Masanori Sawa (Kobe University, Japan)

14:40-15:20 [Special Talk] *Infinite structures with finite VC_n-dimension*
Kota Takeuchi (University of Tsukuba, Japan)

15:30-16:00 *On a Fraïssé-style construction of a countable universal homogeneous graph*
Koichiro Ikeda (Hosei University, Japan)

16:00-16:30 *On countable graphs generated by classes of finite graphs*
Shunsuke Okabe (Kobe University, Japan)

16:40-17:20 [Special Talk] *Adjacency properties of graphs analogous to the countable random graph, their links with combinatorial designs and arrays*
Xiao-Nan Lu (Tokyo University of Science, Japan)

17:30-18:00 *Applications of adjacency properties from the countable random graph to graph-theoretic problems*
Shohei Satake (Kobe University, Japan)

c) Mini Symposium : Graph Structure
(Organizer: Kenta Ozeki)

14:00-14:30 *Closure for $\{K_{1,4}, K_{1,4} + e\}$-free graphs*
Zdeněk Ryjáček (University of West Bohemia, Czech Republic)

14:30-15:00 *On extremal mixed graphs*
James Tuite (Open University, United Kingdom)

15:15-15:45 *Degree powers in graphs with a forbidden forest*
Henry Liu (Sun Yat-sen University, China)

15:45-16:15 *Results related to structures in Gallai colorings*
Roman Čada (University of West Bohemia, Czech)

16:30-17:00 *Every 4-connected graph with crossing number 2 is hamiltonian*
Kenta Ozeki (Yokohama National University, Japan)

Disjoint Cycles and Equitable Colorings in Graphs

Elyse Yeager

University of British Columbia, Canada

The Corrádi-Hajnal Theorem gives a minimum-degree condition for the existence of a given number of vertex-disjoint cycles in a simple graph. We discuss a number of variations on the Corrádi-Hajnal Theorem, changing both the nature of the necessary condition (for example, minimum degree sum instead of minimum degree) and the kind of subgraph whose existence is desired. We also briefly discuss the connections between these types of theorems and equitable graph colourings.

This talk is based on joint work with Hal Kierstead (Arizona State University), Alexandr Kostochka (University of Illinois at Urbana-Champaign), Theodore Molla (University of South Florida), and Michael Santana (Grand Valley State University).

Adjacency properties of graphs and related results

Shohei Satake

Kobe University, Japan

Let l and m be non-negative integers such that $l + m$ is positive. A graph G satisfies the adjacency property $\mathcal{P}(l, m)$ if for any disjoint subsets of vertices A and B such that $|A| = l$ and $|B| = m$, there exists a vertex $z \notin A \cup B$ such that z is adjacent to all vertices of A, but none of B. In this talk, we construct infinite families of graphs satisfying $\mathcal{P}(l, m)$. We also give applications of the adjacency property $\mathcal{P}(l, m)$ to some graph-theoretic and number-theoretic problems.

Binary linear complementary dual codes

Ken Saito

Tohoku University, Japan

Linear complementary dual (abbreviated LCD) codes are linear codes whose intersection with their dual are trivial. LCD codes provide an optimum linear coding solution for the two-user binary adder channel. It is a fundamental problem to classify LCD codes for modest lengths n and dimensions k. In this talk, we give a characterization of binary LCD codes using k-covers of a finite set and give a classification of binary LCD codes with the largest minimum weights for $1 \leq k \leq n \leq 16$. This talk is based on joint work with Masaaki Harada (Tohoku University).

Results on Sigma Colorings of Planar Graphs

Hsin-Hao Lai

National Kaohsiung Normal University, Taiwan

A sigma coloring of a graph G is a labeling from the vertex set of G to the set of positive integers such that for every two adjacent vertices the sums of integers assigned to their neighbors are different. The sigma chromatic number of a graph G is the minimum number of colors required in a sigma coloring of G.

In this talk, I will present some results on sigma colorings of planar graphs and Halin graphs.

On a relationship between X-codes and separating parity-check matrices

Yu Tsunoda

Chiba University, Japan

We give bounds on and a relationship between two distinct kinds of combinatorial structures in coding theory. One is a class of binary matrices for data compression in integrated circuit testing, called X-codes. The other is a kind of parity-check matrix for a q-ary linear code for an error-erasure channel, called a separating parity-check matrix. This talk presents some results on each of the two structures by the probabilistic method in combinatorics and explains an interesting relationship between them. This talk is based on joint work with Yuichiro Fujiwara (Chiba University), Hana Ando (Chiba University), and Peter Vandendriessche (Ghent University).

A Closed Knight's Tour Problem on the $(5, n, 1)$-Tube

Nathaphat Loykaew

Ramkhumhaeng University, Thailand

A closed knight's tour of a chessboard uses legal moves of the knight to visit every square exactly once and return to its starting position. We construct the new chessboard, namely (m, n, r)-tube of width r, by modifying the $m \times m$ chessboard as follows. (i) Remove the middle until the rim contains r rows and r columns and (ii) stack the resulting chessboard in (i) for n copies. The tour within the n stacked copies are consider. In this paper, a closed knight's tour of the $(5, n, 1)$-tube is obtained. This talk is based on joint work with Sirirat Singhun (Ramkhumhaeng University) and Ratinan Boonklurb (Chulalongkorn University).

Constructing new linear codes over the field of order five

Yuto Inoue

Osaka Prefecture University, Japan

An $[n, k, d]_q$ code is a linear code of length n, dimension k and minimum Hamming weight d over the field of order q. In this talk we present how to construct 5-divisible codes to find new $[n, 5, d]_5$ codes attaining the Griesmer bound for some d. This talk is based on joint work with Tatsuya Maruta (Osaka Prefecture University).

The Number of Squares Required k with the $(1, 3)-$ Knight's Move

Ratree Theprod

Ramkhumhaeng University, Thailand

The $(1, 3)$-knight's move is the move with 1 squares vertically or 1 squares horizontally and then 3 squares move at 90 degrees angle. In this talk, we obtain the number of squares reachable in k moves with the $(1, 3)$-knight's move. Moreover, the cumulative number of squares that the knight can reach in k moves is obtained. This talk is based on joint work with Sirirat Singhun (Ramkhumhaeng University) and Ratinan Boonklurb (Chulalongkorn University).

Nonexistence of some Griesmer codes over the field of order five

Wataru Kuranaka

Osaka Prefecture University, Japan

An $[n, k, d]_q$ code is a linear code of length n, dimension k and minimum Hamming weight d over the field of order q. In this talk we show the nonexistence of $[n, 5, d]_5$ codes attaining the Griesmer bound for some d using the geometric method through projective geometry. This talk is based on joint work with Tatsuya Maruta (Osaka Prefecture University).

Embeddings of regular digraphs on surfaces

Gen Kawatani

Tokyo University of Science, Japan

A *regular* digraph is a digraph with the indegree of each vertex equal to its outdegree. An *embedding* of a regular digraph D on a surface $\mathbb{F}$ is vertices and arcs of D placed on $\mathbb{F}$ without crossing arcs or overlapping vertices such that for each vertex v, in-neighbors and out-neighbors of v alternately appear around v on $\mathbb{F}$. The speaker consider several problems for embeddings of regular digraphs and tournaments, which are analogs of theorems in Topological Graph Theory. This is a joint work with Naoki Matsumoto (Seikei University).

Extendability of quaternary linear codes of dimension three

Makoto Shirouzu

Osaka Prefecture University, Japan

A linear code $\mathcal{C}$ of minimum weight d over a given finite field is called l-extendable if $\mathcal{C}$ can be extended to a linear code of minimum weight $d + l$ by adding l coordinates. In this talk we present some new results on the l-extendability of linear codes of dimension 3 over the field of order four. This talk is based on joint work with Tatsuya Maruta (Osaka Prefecture University).

Q_4-irreducible even triangulations of the projective plane

Jun Hasegawa

Niigata University, Japan

In this talk, we show two families of Q_4-irreducible even triangulations of the projective plane P^2. Furthermore, we determine exactly two (P_4, Q_4)-irreducible even triangulations of P^2, which completely correspond to two (P, Q)-irreducible even triangulations of P^2. This fact does not hold for general closed surfaces. This talk is based on joint work with Yusuke Suzuki (Niigata University).

A Systematic Construction of High Index Covering Arrays

Frederick Kin Hing Phoa

Academia Sinica, Taiwan

Orthogonal array has been well-known for its applications in designing factorial experiments. Its existence is restricted as all tuples appear in equal number of times, and it guarantees a standardized estimation on the response variations associated with all tuples. On the other hands, covering array of $\lambda = 1$ is an important class of designs in hardware and software testings. Its existence is less restrictive as all tuples only need to appear at least once, but the responses associated to tuples with only one observation lack the measure on variations and the ability to resist outliers. To bridge the wide spectrum from two extreme settings (orthogonal arrays and covering arrays of $\lambda = 1$) in terms of the number of repeated measures of tuples, we construct a useful class of experimental designs, namely the covering arrays of λ (CA_λ), where $\lambda > 1$. It allows experimenters to adjust their required λ parameter so that all tuples in the resulting CA_λ appear at least λ times. Given the number of factors of interest, CA_λ utilizes less resources than an orthogonal array and gains the ability to resist outliers that a traditional CA_1 fails to achieve. We theoretically study the properties of CA_λ, and develop a systematic method to construct families of CA_λ with small run sizes under different number of factors, number of levels, strength and λ. This talk is based on joint work with Dr. Yasmeen Akhtar (Academia Sinica).

Homogeneity of maps on closed surfaces

Seiya Negami

Yokohama National University, Japan

A map on a closed surface is said to be homogeneous if any isomorphism between two induced submaps extends to an automorphism of the whole map. We shall characterize the homogeneous maps and shall classify those maps on the sphere, the projective plane, the torus and the Klein bottle in particular. Furthermore, we shall show that every closed surface, other than the sphere, admits only finitely many homogeneous maps.

Some existence of perpendicular multi-arrays

Kazuki Matsubara

Chuo Gakuin University, Japan

Several types of combinatorial structures having a splitting-balanced property has been defined with some applications for authentication codes in literature. In this talk, we present some construction methods of perpendicular multi-arrays by use of other combinatorial structures. Furthermore, some interesting results on the existence problem of perpendicular multi-arrays are shown. This talk is based on joint work with Sanpei Kageyama (Tokyo University of Science).

Polynomial ideals associated to combinatorial objects

William J. Martin

Worcester Polytechnic Institute, USA

A recurring theme in algebraic combinatorics is to obtain results about combinatorial objects via the study of spaces of polynomial functions defined on them. There are a number of ways in which one can set up such a theory. In this talk, we represent combinatorial objects as finite sets of vectors in real or complex space and study the restriction of each polynomial function on that vector space to the finite set. Of course, two distinct polynomials may yield the same function on this finite subset, and this happens when their difference belongs to the ideal of polynomials which vanish on the set. We show how this ideal of polynomials captures structural information about combinatorial designs, error-correcting codes, spherical codes and designs, and association schemes. Part of of this talk is based on joint work with Corre Steele (formerly WPI) and part is based on joint work with Doug Stinson (Waterloo).

Degree conditions for partitioning graphs into chorded cycles

Shuya Chiba

Kumamoto University, Japan

In 1997, Brandt, Chen, Faudree, Gould and Lesniak [Degree conditions for 2-factors, J. Graph Theory 24, 165–173 (1997)] gave degree conditions for graphs to be partitioned into exactly k cycles. In this study, we extend this result to a "chorded cycle" version. A chorded cycle of a graph G is a subgraph of G consisting of a cycle and an additional edge joining two vertices of the cycle. We give sharp degree conditions for graphs to be partitioned into exactly k chorded cycles and show that our result is a generalization of the result of Brandt et al. This talk is based on joint work with Shoichi Kamada (Kumamoto University).

Balancedly splittable Hadamard matrices

Sho Suda

Aichi University of Education, Japan

In this talk we introduce the concept of balancedly splitattble Hadamard matrices. We then study connections to strongly regular graphs, equiangular lines sets and construct association schemes by Latin squares. This talk is based on joint work with Hadi Kharaghani (University of Lethbridge).

Degree sum conditions for bipartite graphs to have S-path-systems

Takamasa Yashima

Keio University, Japan

Let G be a graph, and S be a subset of the vertex set of G. We denote the set of the end vertices of a path P by $end(P)$. A path P is an *S-path* if $|V(P)| \geq 2$ and $V(P) \cap S = end(P)$. An *l-S-path-system* $\mathcal{P}$ is a set of vertex-disjoint S-paths such that $S = \bigcup_{P \in \mathcal{P}}(V(P) \cap S)$ and $|V(P)| \leq l$ for any $P \in \mathcal{P}$. In this talk, we will present some results on the degree sum condition for bipartite graphs to have l-S-path-systems with l small. This talk is based on joint work with Masao Tsugaki (Tokyo University of Science).

Relative t-designs on one shell of Johnson association schemes

Yan Zhu

Shanghai University, China

Relative t-designs, as a generalization of combinatorial t-designs, are defined on both P-polynomial and Q-polynomial association schemes. We focus on relative t-designs on one shell X_r for these two structures. It is expect to identify such designs as harmonic index T-designs on X_r for some subset T when X_r is commutative. In the present talk, we will discuss such set T for $J(v,k)$. Each nontrivial shell X_r of $J(v,k)$ is known to be a commutative association scheme which is the product of two smaller Johnson association schemes, where $X_r = \{x \in \binom{V}{k} : |x \cap x_0| = k - r\}$ for a fixed k-subset x_0. We determine that the set T is $\{(k,\ell) \neq (0,0) \mid 0 \leq k, \ell \leq t\}$ (resp. $\{(k,\ell) \mid 0 < k + \ell \leq t\}$) for P-polynomial (resp. Q-polynomial) structure of $J(v,k)$. In addition, we will discuss the existence problems of tight relative t-designs on one shell of $J(v,k)$ for small t.
This talk is based on a joint work with Eiichi Bannai.

Fault-Tolerant Vertex-Pancyclicity of Crossed Cubes CQ_n

Xirong Xu

Dalian University of Technology, China

In this talk we present the result on the fault-tolerant vertex-pancyclicity of CQ_n, and show that if $CQ_n (n \geq 3)$ contains at most $n-3$ faulty vertices and/or edges then, for any fault-free vertex u and any integer l with $6 \leqslant \ell \leqslant 2^n - f_v$ except $l = 7$, there is a fault-free cycle of length l containing the vertex u, where f_v is the number of faulty vertices. The result is optimal in some senses.

This talk is based on joint work with Huifeng Zhang,Pir Dino Soomro,Huijun Jiang(Dalian University of Technology) and Lingqi Zhao(Inner Mongolia University for Nationalities).

Complex Hadamard matrices attached to 3-class commutative nonsymmetric association schemes

Takuya Ikuta

Kobe Gakuin University, Japan

In this talk we present a classification of complex Hadamard matrices attached to 3-class commutative nonsymmetric association schemes. In consequence of our classification, we show that such a matrix is necessarily one of complex Hadamard matrices on a complete multipartite graph, including Bush-type complex Hadamard matrices, and examples of eight and sixteen vertices. This talk is based on joint work with Akihiro Munemasa (Tohoku University).

Re-embedding structures of 3-connected 3-regular planar graphs into nonorientable closed surfaces

Kengo Enami

Yokohama National University, Japan

It is well-known that every 3-connected planar graph is uniquely embeddable on the sphere but it is not unique for non-spherical cases. In this talk, we shall focus on 3-connected 3-regular planar graphs and classify structures of these embeddings on the projective plane and Klein bottle. Moreover, we will also present the case of nonorientable closed surfaces with higher crosscap number.

Great antipodal sets on unitary groups and Hamming graphs

Hirotake Kurihara

National Institute of Technology, Kitakyushu College, Japan

The unitary group $U(n)$ is a symmetric space and has the point-symmetry for every point $g \in U(n)$. A *great antipodal set* on $U(n)$ is a "good" finite subset of $U(n)$ related to the point-symmetries. We can obtain the Hamming graph $H(n, 2)$ from a great antipodal set in a "natural way". In this talk, we present some relations between harmonic analysis on $U(n)$ and harmonic analysis on $H(n, 2)$ in terms of design theory.

1-Embeddability of complete multipartite graphs on the projective plane

Hikari Shibuya

Niigata University, Japan

A simple graph G is 1-*embeddable* into a closed surface F^2 if G can be drawn on F^2 so that each of its edges crosses at most one other edge at a point. In this talk, we present the full characterization of 1-embeddable complete k-partite graphs into the projective plane. This talk is based on joint work with Yusuke Suzuki (Niigata University).

Enumerating partial Latin rectangles

Rebecca J. Stones

Nankai University, China

We describe computational methods for enumerating m-entry $r \times s$ partial Latin rectangles on n symbols. This talk is based on joint work with Raúl M. Falcón (University of Seville).

Exceptional balanced triangulations of surfaces

Yusuke Suzuki

Niigata University, Japan

In this talk, we show that two balanced triangulations of the sphere are connected by a sequence of pentagon contractions and their inverses if none of them is isomorphic to the octahedron, which is the *exceptional* one on the sphere. Furthermore, we show some results of exceptional balanced triangulations on other surfaces. This talk is based on joint work with Satoshi Murai (Osaka University).

Totally Symmetric Latin Squares with Trivial Autotopism Groups

Trent G. Marbach

Nankai University, China

A totally symmetric Latin square is identical to each of its six conjugates. The autotopism group of a Latin square is the set of symmetries where we permute the rows, columns, and symbols. We present our work on finding totally symmetric Latin squares with a trivial autotopism group. This talk is based on joint work with Rebecca J. Stones (Nankai University, China) and Raúl M. Falcón (University of Seville, Spain).

On the partial order competition dimension and the chromatic number of a graph

Yoshio Sano

University of Tsukuba, Japan

The *competition graph* of a digraph D is the intersection graph of the family of the out-neighborhoods of the vertices of D. For a finite subset S of $\mathbb{R}^d$, let D_S be the digraph defined by $V(D_S) = S$ and $A(D_S) = \{(x, v) \mid v, x \in S, v \prec x\}$, where $x \prec y$ means $x_i < y_i$ for each $i = 1, \ldots, d$. A *d-partial order* is a digraph isomorphic to D_S for some finite subset S of $\mathbb{R}^d$. For a graph G, the *partial order competition dimension* of G, denoted by $\dim_{\mathrm{poc}}(G)$, is the smallest nonnegative integer d such that G together with sufficiently many isolated vertices is the competition graph of a d-partial order. In this talk, we present some results on the partial order competition dimension of a graph and also show some relationship between the partial order competition dimension of a graph and the chromatic number of a graph.

Skew hook formula for d-complete posets

Soichi Okada

Nagoya University, Japan

Proctor introduced a class of posets, called d-complete posets, as a generalization of Young diagrams and shifted Young diagrams, and obtained in collaboration with Peterson a hook formula for the P-partitions on a d-complete posets P. In this talk, we use the notion of excited diagrams to present a similar formula for the "skew diagram" $P \setminus F$ obtained from a d-complete poset by removing an order filter F. This formula generalizes Naruse's hook formula for the number of standard tableaux on a skew Young diagram. This talk is based on joint work with Hiroshi Naruse (University of Yamanashi).

The Size Ramsey Number Involving P_3

Denny Riama Silaban

Universitas Indonesia, Indonesia

Let G and H be simple graphs. The size Ramsey number $\hat{r}(G,H)$ is the smallest number $\hat{r}$ such that there exists a graph F with size $\hat{r}$ satisfying the property that any 2-coloring of the edges of F contains a monochromatic G or H. If the order of F in the size Ramsey number equals to the Ramsey number, $r(G,H)$, then it is called the restricted size Ramsey number $r^*(G,H)$. Let $\hat{R}(G,H)$ be the size of complete graph of order $r(G,H)$. In 2002, Faudree and Schelp proposed two questions; (1) Which pairs of graph (G_n,H_n), neither of which is a complete graph, have the property that $\hat{r}(G_n,H_n) = \hat{R}(G_n,H_n)$? In particular, is this family finite or infinite? (2) Is it true that if H is a fix graph, then $\hat{r}(K_n-H,K_n-H) = r^*(K_n-H,K_n-H)$ for n sufficiently large? In particular, is $\hat{r}(K_n-e,K_n-e) = r^*(K_n-e,K_n-e)$? In this work, we answer the above both question when one of the graph involved is a P_3. Precisely, we show that there are graphs H_n such that $\hat{r}(P_3,H_n) = \hat{R}(P_3,H_n)$. And, since $P_3 \cong K_3-e$, we also show that $\hat{r}(K_3-e,K_n-e) = r^*(K_3-e,K_n-e)$.

A nice partition function for reverse plane partitions derived from a discrete integrable system

Shuhei Kamioka

Kyoto University, Japan

A reverse plane partition is a filling of a Young diagram, or a shape, with nonnegative integers such that each row and column are weakly increasing. Enumeration of reverse plane partitions is an important subject in enumerative combinatorics. In this talk we show a new partition function for reverse plane partitions derived from a specific solution to a discrete integrable system. The new partition function admits a nice product formula which generalizes MacMahon's formula for plane partitions and Gansner's hook formula for reverse plane partitions. Symmetric reverse plane partitions are also discussed.

Unique realisations of graphs

Katie Clinch

University of Tokyo, Japan

A *realisation* p *of a graph* G *in* $\mathbb{R}^d$ assigns a location $p(v) \in \mathbb{R}^d$ to each vertex $v \in V(G)$. We can think of the resulting *framework* (G, p) as a drawing of the graph in $\mathbb{R}^d$. A well-studied question is: given such a framework, is there another realisation q in $\mathbb{R}^d$ such that the line segment corresponding to each edge has the same length in both (G, p) and (G, q)? We exclude trivial examples, such as when (G, q) is a translation of (G, p). In this talk, we consider variants of this problem in $\mathbb{R}^2$.

Signed Mahonian identities on permutations

Sen-Peng Eu

National Taiwan Normal University, Taiwan

We answer a question posed by Caselli in [*Journal of Combinatorial Theory, series A* (119), 2012], which asks for a proof of a signed Mahonian equality over two parabolic quotients (parameterized by k) of the symmetric group on $[n]$ when n is even or k is odd. We give a full explanation of the roles of the parities of n and k. The result is extended and signed Mahonian identities over various families of permutations are derived. This talk is based on joint work with Hsiang-Chun Hsu, Hsin-Chie Liao and Wei-Liang Sun.

A new Bartholdi zeta function for a graph

Lin Zhu

Shanghai Jiao Tong University, China

In this talk we define a new Bartholdi zeta function for a graph and give determinant expression of it. We will show that the $(n+1)$-variable Bartholdi zeta function defined by Iwao Sato and his coauthors can be obtained by specializing variables in our new Bartholdi zeta function.

On enumeration of restricted permutations of genus zero

Tung-Shan Fu

National Pingtung University, Taiwan

The genus of a permutation σ of length n is the non-negative integer g_σ given by $n + 1 - 2g_\sigma = z(\sigma) + z(\sigma^{-1}\tau)$, where $z(\sigma)$ is the number of cycles of σ, and τ is the circular permutation $\tau = (1, 2, \ldots, n)$. On the basis of a realization of the genus zero permutations in terms of non-crossing partitions, we obtain enumerative results for some families of restricted permutations. This talk is based on joint work with Sen-Peng Eu, Yeh-Jong Pan and Chien-Tai Ting.

The Set Chromatic Number of Circulant Graphs $C_n(a, b)$

Bryan Ceasar L. Felipe

Ateneo de Manila University, Philippines

For a graph G, let $c : V(G) \to \mathbb{N}$ be a vertex coloring of G. The *neighborhood color set* of a vertex v in G, denoted by $\mathrm{NC}(v)$, is the set of colors of the neighbors of v. The coloring c is referred to as a *set coloring* if no two adjacent vertices have the same neighborhood color set. The minimum number of colors needed for G to have a set coloring is called the *set chromatic number* of G and it is denoted by $\chi_s(G)$. In this talk, we show the set chromatic number of circulant graphs $C_n(a, b)$. This talk is based on the joint work with Agnes D. Garciano (Ateneo de Manila University).

Using Partition and Extension to Build Large Permutation Arrays for Hamming Distances

Hal Sudborough

University of Texas at Dallas, USA

Permutations σ and π on Z_n have Hamming distance d ($hd(\sigma, \pi) = d$) if there are d integers x where $\sigma(x) \neq \pi(x)$. For a permutation array (PA) A, $hd(A) = d$ if all permutations in A have pairwise Hamming distance d. Partition and Extension (P&E) transforms a PA A on Z_n with $hd(A) = d$ to a PA A' on Z_{n+1} with $hd(A') = d + 1$. Let $M(n, d)$ denote the size of the largest PA A on Z_n such that $hd(A) = d$. P&E improves lower bounds on $M(n, d)$ over those based on MOLS. We describe P&E, how it beats MOLS results, and new theorems for $M(q + 1, d)$ for prime powers q.

This talk is based on joint work with Sergey Bereg, Zachary Hancock, Linda Morales, and Alexander Wong (University of Texas at Dallas).

The Sigma Chromatic Number of Corona of Cycles or Paths with Complete Graphs

Maria Czarina T. Lagura

University of Santo Tomas-Senior High School, Philippines

For two simple connected graphs G and H, the *corona of G and H*, denoted by $G \odot H$ is the graph obtained by taking one copy of G and $|V(G)|$ copies of H and where the ith vertex of G is adjacent to every vertex of the ith copy of H.

Let $c : V(G) \to \mathbb{N}$ be a coloring of the vertices in G, where two adjacent vertices may be assigned the same color. For any $v \in V(G)$, let $\sigma(v)$ be the sum of colors of the vertices adjacent to v. Then c is called a sigma coloring of G if for any two adjacent vertices $u, v \in V(G), \sigma(v) \neq \sigma(u)$. The minimum number of colors needed in a sigma coloring of G is the sigma chromatic number of G, denoted by $\sigma(G)$.

In this study we will present sigma colorings of $G \odot H$ where G is a cycle or a path and H is a complete graph. Consequently, we will determine the sigma chromatic numbers of these types of graphs. Particularly, we will show that $\sigma(P_m \odot K_n) = n$ for any pair of positive integers $m, n \geq 2$ and that $\sigma(C_m \odot K_n) = n$ for any pair of positive integers $m, n \geq 3$. Furthermore we will show that $\sigma(C_m \odot K_2) = \sigma(C_m)$. For a general graph G, we will show that $\sigma(G \odot Kn) \leq \max\{\sigma(G), n\}$.

This talk is based on joint work with co-authors Dr. Agnes D. Garciano, Dr. Reginaldo M. Marcelo (Ateneo de Manila University) and Nelson R. Tumala Jr. (Ozamiz City National High School).

The Allocation of Array Storage in Parallel Memory Modules

Chih-Hung Yen

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

As the effective speeds of central processing units (CPUs) have increased, more parallel memory modules have been used in computers. One of the most difficult tasks in organizing the program of a computer is the allocation of array storage for avoiding that accessing conflicts arise and thus effectively slowing down the computer. Hence, how do we store the array of data so that all the data elements comprising any desirable array subpart are stored in different memory modules? In this talk we present some results of tessellating polyominoes in the plane which apply to such a problem. This talk is based on joint work with Chia-Ying Wu (National Chiayi University) and Chi-Sung Su (National Chiayi University).

On the Sigma Value and Range of the Join of a Finite Number of Paths

Marie Cris A. Bulay-og

Ateneo de Manila University, Philippines

Let G be a simple connected graph and $c : V(G) \to \mathbb{N}$ be a vertex coloring of G, where adjacent vertices may be colored the same. For any $v \in V(G)$, let $\sigma(v)$ be the sum of the colors of the vertices adjacent to v. If $\sigma(u) \neq \sigma(v)$ for any two adjacent vertices $u, v \in V(G)$, then c is called a *sigma coloring* of G. The minimum number of colors required in a sigma coloring of G is called its *sigma chromatic number* and is denoted by $\sigma(G)$.

Suppose that $\sigma(G) = k$. The *sigma value* of G, denoted by $\nu(G)$, is the smallest positive integer m for which there exists a sigma coloring of G using k colors from the set $\{1, 2, 3, \cdots, m\}$. On the other hand, the *sigma range* of G, denoted by $\rho(G)$, is the smallest positive integer for which there exists a sigma coloring of G using colors from the set $\{1, 2, 3, \cdots, k\}$.

In this paper, we determine the sigma value and range of the join of a finite number of graphs. In particular, if $G = \sum_{i=1}^{l} P_{n_i}$ with $1 \leq n_1 < n_2 < \cdots < n_l$ and $n_{i+1} - n_i \geq 2$ for each $1 \leq i \leq l-2$, then we show that $\rho(G) = \nu(G) = 2$. Furthermore, if $G = \sum_{i=1}^{l} P_{n_i}$ with $13 \leq n_1 \leq n_2 \leq \cdots \leq n_l$ and $n_{i+2} - n_i \geq 4$ for each $1 \leq i \leq l-2$, then $\rho(G) = \nu(G) = 2$.

This talk is based on joint work with Dr. Agnes D. Garciano and Dr. Reginaldo M. Marcelo (Ateneo de Manila University).

Explicit Constructions for Coded Caching Schemes

Minquan Cheng

Guangxi Normal University, China

Coded caching scheme has recently become quite popular in the wireless network due to the efficiency of reducing the load during peak traffic times. Recently the most concern is the problem of subpacketization level in a coded caching scheme. Although there are some classes of constructions, these schemes only apply to some individual cases for the memory size. And in the practice it is very crucial to consider any memory size. In this talk, several classes of new schemes with the wide range of memory size are proposed. And through the performance analyses, our new scheme can significantly reduce the level of subpacketization by decreasing a little efficiency of transmission in the peak traffic times. Moreover some schemes satisfy that the packet number is polynomial or linear with the number of users.

Combinatorial Reciprocity Theorems

Matthias Beck

San Francisco State University, USA

A common theme of enumerative combinatorics is formed by counting functions that are polynomials. For example, one proves in any introductory graph theory course that the number of proper k-colorings of a given graph G is a polynomial in k, the *chromatic polynomial* of G. Combinatorics is abundant with polynomials that count something when evaluated at positive integers, and many of these polynomials have a (often completely different) interpretation when evaluated at negative integers: these instances go by the name of *combinatorial reciprocity theorems*. For example, when we evaluate the chromatic polynomial of G at -1, we obtain (up to a sign) the number of *acyclic orientations* of G, that is, those orientations of G that do not contain a coherently oriented cycle.

Combinatorial reciprocity theorems appear all over combinatorics. This talk will attempt to show some of the charm (and usefulness!) these theorems exhibit. Our goal is to weave a unifying thread through various combinatorial reciprocity theorems, by looking at them through the lens of geometry.

On some topological upper bounds of the apex trees

Sarfraz Ahmad

COMSATS Institute of Information Technology, Lahore-Pakistan, Pakistan

If a graph G turned out to be a planar graph by removal of a vertex (or a set of vertices) of G, then it is called an apex graph. These graphs play a vital role in the chemical graph theory. On the similar way, a k-apex tree T_n^k is a graph which turned out to be a tree after a removal of k vertices such that k is minimum with this property. Here $|V(T_n^k)| = n$, the cardinality of the set of vertices. In this article, we study different topological indices of apex trees. In particular, we provide upper bounds for the geometric-arithmetic index, the atom bond connectivity index, the augmented Zagreb index and the inverse sum index of the apex and k-apex trees. We identity the graphs for which the equalities hold.

Regular unimodular triangulations of dilated empty simplices and Gröbner basis

Akihiro Higashitani

Kyoto Sangyo University, Japan

Empty simplex is a kind of a lattice polytope and play a crucial role in combinatorics of lattice polytopes. On the other hand, the existence of a unimodular triangulation of a lattice polytope is important in several points of view. In this talk, we will discuss the existence of a regular unimodular triangulation of a dilation of a certain empty simplex. The proof is given by using the theory of Gröbner basis of the toric ideal associated to a lattice polytope. This talk is based on the joint work with Takayuki Hibi and Koutarou Yoshida (Osaka University).

Network model for the spreading of Influenza virus

Puntani Pongsumpun

King Mongkut's Institute of Technology Ladkrabang, Thai

Influenza virus can easily transfer between people and it can be found around the world. The SIRS (Susceptible-Infectious-Recovered-Susceptible) epidemic is used for describing the transmission of this virus. It is an epidemiological model that computes the number of susceptible, infected and recovered human over time. The epidemic of this virus can transfer from person to person as network transmission. For looking the network epidemic of this virus, it is necessary to evaluate the variance of the number of infected nodes. We apply the N-intertwined model defined by adjacency matrix to determine the variance. The results of this study should be the way to better understanding the influenza epidemic.

The Converse of Pentagonal Subdivision

Min Yan

Hong Kong University of Science and Technology, Hong Kong

Given any tiling of oriented surface, the pentagonal subdivision produces a tiling by pentagons, such that the degree of the vertices of each tile are $3, 3, 3, p, d$, where d is the degree of a vertex in the original tiling, and p is the number of edges of a tile in the original tiling. As a partial converse, we show that, if a pentagonal tiling has the property that the vertices of each tile are $3, 3, 3, 3, d$, with $d > 3$, then the tiling is a pentagonal subdivision.

The motivation for such a converse is the problem of the distribution of high degree (i.e., degree > 3) vertices in pentagonal tilings of the sphere. Moreover, a related problem is generic and degenerate tilings. We will discuss both issues and consider other possible variations of the converse of the pentagonal subdivision.

On the Optical and Forwarding Indices of Graphs

Yuan-Hsun Lo

Xiamen University, China

The optical index is the minimum number of wavelengths needed to solve the routing and wavelength assignment problem, which arises from the investigation of optimal wavelength allocation in an optical network that employs Wavelength Division Multiplexing (WDM). The arc-forwarding index is known to be a natural lower bound of the optical index. In this talk, we will give a brief survey and some recent progress on the optical and arc-forwarding indices, as well as their undirected version: undirected optical and edge-forwarding indices. This talk is based on joint work with Hung-Lin Fu (National Chiao Tung University).

Almost Equilateral Pentagonal Tilings of the Sphere

Hoi Ping LUK

The Hong Kong University of Science & Technology, Hong Kong

The classification of edge-to-edge tilings of the sphere by congruent pentagons can be divided into three cases: variable edge lengths, equilateral, and almost equilateral. The first two have been largely settled by the authors and collaborators. The almost equilateral case (four edges having equal length, and the fifth not) is the most difficult, and techniques developed for the first two cases are not enough. With significant aid of decision-making type algorithms in Maxima, we have developed new techniques. We obtained the full classification of the almost equilateral case with three distinct angles and found partial results with five distinct angles. This talk is based on the paper in collaboration with Min Yan, The Hong Kong University of Science & Technology.

The complete classification of empty lattice 4-simplices

Francisco Santos

Universidad de Cantabria, Spain

A *lattice polytope* is the convex hull in $\mathbb{R}^d$ of finitely many points of $\mathbb{Z}^d$ (or of any other geometric lattice $\Lambda \subset \mathbb{R}^d$). A *lattice d-simplex* is a lattice d-polytope whose vertices are affinely independent and with no other lattice point. Equivalently, it is a lattice d-polytope with exactly $d+1$ lattice points. By *classification* we mean modulo *unimodular equivalence*, that is, modulo affine transformations $\Lambda \to \Lambda$.

Lattice polytopes have been widely studied for their relations to algebraic geometry and integer optimization, among other fields. For example, empty lattice simplices correspond to the so called *terminal quotient singularities* in the minimal model program of Mori for the birational classification of algebraic varieties. Their classification in dimension three (White, 1964) is sometimes dubbed the *terminal lemma*, and quite some effort has been devoted towards the classification of 4-dimensional ones. In particular, Mori, Morrison and Morrison (1988) conjectured a classification of the empty 4-dimensional simplices of *prime volume* into a three-parameter family, one two-parameter family, 29 one-parameter families, and a finite list of exceptions of volumes up to 419. This classification was later proved by Bober (2009).

For the non-prime case, Barile et al. (2011) claimed that the classification of Mori et al. extended without change (except for an increase in the number of exceptional simplices) but this statement was found to be false in Blanco et al. (2017+), where additional infinite families were found. In this talk we report on the complete classification of empty 4-simplices.

In order to state our classification let us explain an intrinsic way of representing a lattice simplex. Let $P = \operatorname{conv}(v_0, \dots, v_d)$ be a lattice d-simplex with respect to a given lattice Λ. Let Λ_0 be the affine sublattice generated by $v_0, \dots, v_d$, so that the *normalized volume* of P is $V := |\Lambda : \Lambda_0|$. Then, every point $p \in \operatorname{aff}(\Lambda)$ can be uniquely reperesented in barycentric coordinates by a vector $(b_0, \dots, b_d)$ with $\sum_i b_i = 1$, meaning by this that $p = \sum_i b_i p_i$. Moreover, two points p, p' have barycentric coordinates differing by an integer vector if and only if they lie in the same translate of Λ_0.

In particular, if we let

$$\mathbb{T}^d \quad := \quad \{(b_0, \dots, b_d) \in \mathbb{R}^{d+1} : \sum_i b_i = 1\} / \{(b_0, \dots, b_d) \in \mathbb{Z}^{d+1} : \sum_i b_i = 1\} \cong \mathbb{R}^d / \Lambda_0$$

be the homogeneous real torus of dimension d, then every lattice simplex P of volume V induces a subgroup $G(P) \cong \Lambda/\Lambda_0$ of order V of $\mathbb{T}^d$. Moreover:

Proposition *Two simplices P and P' are equivalent if and only if $G(P)$ and $G(P')$ are the same group modulo permutation of coordinates.*

That is, we can represent a lattice simplex P as a finite subgroup $G(P)$ of $\mathbb{T}^d$. This approach is specially useful for *cyclic simplices*, by which we mean that $G(P)$ is a cyclic group, since a cyclic d-simplex can be represented as the $(d+1)$-tuple of a generator of $G(P)$. Barile et al. (2011) showed that every empty lattice simplex of dimension four is cyclic.

In the following statement, which summarizes our classification, a *hollow* polytope is a lattice polytope with no lattice points in its interior. The *width* of a body $K \subset \mathbb{R}^d$ with respect to a linear functional $f : \mathbb{R}^d \to \mathbb{R}$ is the length of the interval $f(K)$. The *(lattice) width* of a lattice polytope P the minimum width of P with respect to all non-constant affine functionals with $f(\Lambda) \subset \mathbb{Z}$.

Theorem (Classification of empty 4-simplices) *Let P be an empty 4-simplex of normalized volume V. and let $d' \in \{1, 2, 3, 4\}$ be the minimum dimension of a hollow polytope that P projects to. Then P lies in one of the following explicitly described categories.*

$\boxed{d' = 1\text{:}}$ *P has width one and its quintuple is of the form $\frac{1}{V}(-a, -b, a+b, -1, 1)$ with $\gcd(a, b, V) = 1$.*

$d' = 2$: *P has width two and projects to the second dilation of a unimodular triangle. There are two possibilities for the quintuple, namely:*

$$\frac{1}{V}(a, -2a, b, -2b, a+b), \qquad \textit{and} \qquad \frac{1}{2}(0,0,1,0,1) + \frac{1}{V}(2,-1,-1,a,-a).$$

$d' = 3$: *P has width two and projects to a hollow triangular bipyramid. There are 29 + 23 possibilities for the quintuple: The 29 "stable quintuples" identified by Mori, Morrison and Morrison (1988) plus 23 "non-primitive quintuple".*

$d' = 4$: *P does not project. There are exactly 2461 possibilities for P, with volumes ranging from 24 to 419. According to their width they fall in 2282, 178 and 1 classes of widths 2, 3 and 4, respectively.*

This talk is based on joint work with Óscar Iglesias-Valiño (Universidad de Cantabria).

An algorithm for finding triad colorings of triangulations on closed surfaces

Yumiko Ohno

Yokohama National University, Japan

Let G be a triangultion on a closed surface. A coloring $c : V(G) \to \mathbb{Z}_n$ is called an *n-triad coloring* if $\{c(u), c(v), c(w)\}$ belongs to $\{\{i, i+1, i+2\} \mid i \in \mathbb{Z}_n\}$ for any face uvw of G. We would like to determine the set of integers n such that G has n-triad colorings. If G is on the sphere or the projective plane, then such a set has been completely determined according to the chromatic number of G. In this talk, to find the set regardless of closed surfaces, we shall consider an algorithm which investigates the integers n such that G has n-triad colorings.

Reflexive polytopes arising from edge polytopes

Akiyoshi Tsuchiya

Osaka University, Japan

It is known that every lattice polytope is unimodularly equivalent to a face of some reflexive polytope. A stronger question is to ask whether every $(0, 1)$-polytope is unimodularly equivalent to a facet of some reflexive polytope. A large family of $(0, 1)$-polytopes are the edge polytopes of finite simple graphs. In this talk, it is shown that, by giving a new class of reflexive polytopes, each edge polytope is unimodularly equivalent to a facet of some reflexive polytope. This talk is based on joint work with Takahiro Nagaoka (Kyoto University).

Stable embeddings of graphs on closed surfaces with minimum length

Naoki Mochizuki

Yokohama National University, Japan

We embed a graph G on a closed surface F^2 having some metric and consider the total sum of lengths of edges measured by the metric. An embedding $f : G \to F^2$ is said to be *stable* (with respect to minimum length) if the set of embeddings isotopic to f has a minimum element. We shall characterize and discuss stable and unstable 3-regular graph embeddings on the unit flat torus.

The combinatorics of hyperplane arrangements and the geometry of hypertoric varieties

Takahiro Nagaoka

Kyoto University, Japan

Hypertoric varieties are algebraic varieties analogous to toric varieties, and they are of importance in algebraic geometry and geometric representation theory. For each affine hypertoric variety $Y(A, 0)$, we can associate a central hyperplane arrangement $\mathcal{H}_A$, and we can read off some geometric properties of $Y(A, 0)$ from the combinatorics of $\mathcal{H}_A$. Particularly, we note that the number of " good " resolution of singularity (so called, crepant resolution) of hypertoric variety $Y(A, 0)$ can be computed from the characteristic polynomial of $\mathcal{H}_A$.

By classification results, each 4-dimensional affine hypertoric variety is isomorphic to one of the following;

(1) (A_{ℓ_1-1}-type surface singularity) $\times$ (A_{ℓ_2-1}-type surface singularity)

(2)

$$Y(A_{\ell_1,\ell_2,\ell_3}) = \overline{\mathcal{O}^{min}}(\{\ell_1,\ell_2,\ell_3\}) := \left\{ \begin{pmatrix} u_1 & x_{12} & x_{13} \\ y_{12} & u_2 & x_{23} \\ y_{13} & y_{23} & u_3 \end{pmatrix} \in \mathfrak{sl}_3 \mid \text{all 2-minors of } \begin{pmatrix} u_1^{\ell_1} & x_{12} & x_{13} \\ y_{12} & u_2^{\ell_2} & x_{23} \\ y_{13} & y_{23} & u_3^{\ell_3} \end{pmatrix} = 0 \right\}$$

,where $\ell_1, \ell_2, \ell_3 \in \mathbb{N}$. Since the number of good resolutions of the first case is known, the interesting question is to compute the characteristic polynomial of the associated hyperplane arrangement $\mathcal{H}_{A_{\ell_1,\ell_2,\ell_3}}$ to the second case.

In this talk, we will compute the characteristic polynomial in the relatively easy case $\ell_2 = 1, 2$ and explain the reason why the case $\ell_2 \geq 3$ is difficult. This talk is based on my master thesis.

Geometric quadrangulations of a polygon

Atsuhiro Nakamoto

Yokohama National University, Japan

A *geometric quadrangulation* of a polygon P is a geometric plane graph obtained from P by adding straight segments to the interior of P to be a quadrangulation. We first define the "spirality" of P as a new notion which measures how close P is to a convex polygon. Using the spirality of P, we describe a condition of P to admit a geometric quadrangulation. Moreover, we also investigate whether two geometric quadrangulations of P can be transformed into each other by edge flips. This talk is based on joint work with Naoki Matsumoto (Seikei University) and Gen Kawatani (Tokyo Science University).

Antiadjacency Spectral Property of Regular Graph

Kiki Ariyanti Sugeng

Universitas Indonesia, Indonesia

There are some matrix representations of a graph which are well known, such as adjacency matrix, Laplacian matrix, distance matrix, etc. If A is an adjacency matrix of a graph G, then $B = J - A$, is called antiadjacency matrix, where J is a matrix with every element is equal to one. In this talk we would like to discuss spectral properties of antiadjacency matrix, especially of regular graph and digraph. Moreover, we also show the relation between the spectral properties of adjacency matrix and its line (di) graph.

Toric Fano varieties associated to graph cubeahedra

Yusuke Suyama

Osaka University, Japan

The graph cubeahedron of a finite simple graph is a Delzant polytope obtained from a cube by truncating the faces corresponding to connected induced subgraphs in increasing order of dimension. In this talk, we give a necessary and sufficient condition for the nonsingular projective toric variety associated to the graph cubeahedron to be Fano or weak Fano in terms of the graph.

Classifications of lattice polytopes by their volume

Gabriele Balletti

Stockholm University, Sweden

A well known result by Lagarias and Ziegler states that, up to equivalence, there are finitely many d-dimensional lattice polytopes whose volume is lower then a fixed constant. This is proven by showing that any d-dimensional lattice polytope P has a unimodular copy which fits in a box having side lengths depending only on the volume of P. Since there are finitely many lattice points in the box, then there can be only finitely many d-dimensional lattice polytopes having the volume equal to (or lower than) the volume of P. One can think about using this algorithm for enumerating all the lattice polytopes having dimension and volume "small enough", but when it comes to actual implementations, this strategy seems to be extremely inefficient.

We describe an alternative proof of the result by Lagarias and Ziegler that has the advantage of leading to an implementable algorithm. The key is to build the polytopes "from below" (starting from a simplex and adding vertices) instead of "from above" (starting from a big box, and look inside). For example, in dimension three, we were able to obtain the complete list of all the lattice polytopes having normalized volume at most 36, and all the lattice simplices having normalized volume up to 1000. Similiar classifications are currently being performed up to dimension 10. The three dimensional case can be compared with existing classifications. In particular our list includes a classification of smooth three dimensional smooth polytopes by Lundman (which, in turn, extends one by Bogart et al.), and the list of maximal hollow three dimensional polytopes by Averkov, Wagner and Weismantel. Moreover, thanks to a result by Pikhurko, all the three dimensional simplices having up to 11 interior lattice points are classified. We use this fact to conjecture a set of strict inequalities that fully describe the Ehrhart h^*-polynomials of three dimensional lattice polytopes. One of them surprisingly seems to be non-linear.

On Gelfand-Cetlin polytopes

Yunhyung Cho

Sungkyunkwan University, Republic of Korea

A *Gelfand-Cetiln polytope* $\mathcal{P}$ is a rational convex polytope which is an image of a certain completely integrable system, called the *Gelfand-Cetlin system*, on a partial flag variety. In this talk, we first describe the face structure of $\mathcal{P}$ using so-called a *ladder diagram*. Then, we illustrate how the combinatorics of $\mathcal{P}$ can be used for studying symplectic geometry of flag varieties. Finally, we suggest its generalization to string polytopes and discuss the wall crossing phenomena in mirror symmetry.

Classification of Ehrhart polynomials (in particular, of zonotopes)

Matthias Beck

San Francisco State University, USA

The *Ehrhart polynomial* of a lattice polytope P encodes fundamental arithmetic data of P, namely, the number of integer lattice points in positive integral dilates of P. Mirroring Herb Wilf's much-cherished and still-wide-open question *which polynomials are chromatic polynomials?*, we give a brief survey of attempts during the last half century to classify Ehrhart polynomials. It turns out that this classification problem is related to that of a whole family of polynomials in combinatorics.

We will present some new results for Ehrhart polynomials of *zonotopes*, i.e., projections of (higher dimensional) cubes. This includes a combinatorial description in terms of refined descent statistics of permutations and a formula in matroidal terms which complements a well-known zonotopal identity of Stanley (1991). Finally, we give a complete description of the convex hull of the Ehrhart coefficients of zonotopes in a given dimension: it is a simplicial cone spanned by refined Eulerian polynomials.

This talk is based on joint work with Katharina Jochemko (KTH) and Emily McCullough (University of San Francisco).

Gallai Ramsey number for K_4

Ingo Schiermeyer

Technische Universität Bergakademie Freiberg, Germany

Given a graph H, the k-coloured Gallai Ramsey number $gr_k(K_3 : H)$ is defined to be the minimum integer n such that every k-colouring (using all k colours) of the complete graph on n vertices contains either a rainbow triangle or a monochromatic copy of H. In 2015, Fox, Grinshpun, and Pach conjectured the value of the Gallai Ramsey numbers for complete graphs. The case when $H = K_3$ was actually verified in 1983 by Chung and Graham. We verify this conjecture for the first open case, when $H = K_4$. Finally, we will report about proving the conjecture for the next case, when $H = K_5$. This is joint work with Colton Magnant and Akira Saito.

Unavoidable trees in a graph with large star chromatic number

Boram Park

Ajou University, Korea

The *chromatic number* of a graph is the minimum k such that the graph has a proper k-coloring. There are many coloring parameters in the literature that are proper colorings that also forbid bicolored subgraphs. Some examples are 2-distance coloring, acyclic coloring, and star coloring, which forbid a bicolored path on three vertices, bicolored cycles, and a bicolored path on four vertices, respectively. We capture this notion by defining an *H-avoiding k-coloring* to be a proper k-coloring that forbids a bicolored subgraph H.

When considering the class $\mathcal{C}$ of graphs with no F as an induced subgraph, it is not hard to see that every graph in $\mathcal{C}$ has bounded chromatic number if and only if F is a complete graph of size at most two. We study this phenomena for the class of graphs with no F as a subgraph for H-avoiding coloring. We completely characterize all graphs F where the class of graphs with no F as a subgraph has bounded H-avoiding chromatic number for a large class of graphs H. As a corollary, our main result implies a characterization of graphs F where the class of graphs with no F as a subgraph has bounded star chromatic number. We also obtain a complete characterization for the acyclic chromatic number. This talk is based on joint work with Ilkyoo Choi (Hankuk University of Foreign Studies) and Ringi Kim (Korea Advanced Institute of Science and Technology).

Rainbow connection parameters and forbidden subgraphs

Xueliang Li

Nankai University, China

Rainbow connection numbers are relatively new graph parameters. They have application background on transferring secure information in communication networks. Diameter is a obvious lower bound for the rainbow connection numbers. A natural question is to ask under what conditions one can upper-bound the rainbow connection numbers by a function of the diameter. In this talk we will give a survey on some forbidden subgraph conditions for this question. Some unsolved questions will also be presented.

On a sufficient condition for a graph with boxicity at most its chromatic number

Akira Kamibeppu

Shimane University, Japan

The *boxicity* of a graph G, denoted by $\mathrm{box}(G)$, is the minimum nonnegative integer k such that G is the intersection graph of a family of boxes in Euclidean k-space, where a *box* in Euclidean k-space is the Cartesian product of k closed intervals on the real line.

In this talk, we give a sufficient condition for a graph G with $\mathrm{box}(G) \leq \chi(G)$, where $\chi(G)$ denotes the chromatic number of G. Recently Chandran et al. pointed out that almost all graphs satisfy $\mathrm{box}(G) > \chi(G)$ by the probabilistic method, but the family of graphs with $\mathrm{box}(G) \leq \chi(G)$ is not narrow.

3-dynamic colorings for triangulations on the closed surfaces.

Yoshihiro Asayama

Yokohama National University, Japan

An r-dynamic k-coloring of a graph G is a proper k-coloring such that any vertex v has at least $min\{r, deg_G(v)\}$ distinct colors in $N_G(v)$. The r-dynamic chromatic number $\chi_r^d(G)$ of a graph G is the least k such that there exists an r-dynamic k-coloring of G. In my talk, I will show some upper bounds $\chi_3^d(G)$ for triangulations on the sphere, the projective plane and the torus. This talk is based on joint work with Yuki Kawasakai (National Institute of Technology, Hiroshima College), Seog-Jin Kim (Konkuk University), Atsuhiro Nakamoto (Yokohama National University) and Kenta Ozeki (Yokohama National University).

On recent progress on graphs with smallest eigenvalue at least -3

Jack Koolen

University of Science and Technology of China, Dutch

In 1976, Cameron et al. showed that any connected graph with smallest eigenvalue at least -2 iis a generalized line graph or has at most 36 vertices. In 1977, Hoffman showed that for $\tau > -1 - \sqrt{2}$ any connected graph with smallest eigenvalue at least τ and large enough minimal degree is a generalized line graph and hence its smallest eigenvalue is at least -2. In this talk I am going to explore whether we can generalize these results to graphs with smallest eigenvalue at least -3. This is based on joint work with Qianqian Yang (USTC) and Jaeyoung Yang (Anhui University).

Maximizing the order of regular bipartite graphs for given valency and second eigenvalue.

Hiroshi Nozaki

Aichi University of Education, Japan

Let $b(k, \lambda)$ be the maximum order of a connected bipartite k-regular graph whose second-largest eigenvalue is at most λ. We show an upper bound for $b(k, \lambda)$, which is based on the linear programming bound. A distance-regular graph that satisfies $g \geq 2d - 2$ attains the bound, where g is the girth and d is the diameter. We can prove the non-existence of bipartite distance-regular graphs with $g \geq 2d-2$ for $d > 26$ by the manner of Fuglister (1987). This is a joint work with Sebastian Cioabă and Jack Koolen.

Edge-regular graphs and regular cliques

Gary Greaves

Nanyang Technological University, Singapore

We solve a problem of Neumaier about the existence of non-strongly-regular edge-regular graphs that possess regular cliques. In this talk, we will present a construction of such graphs. This talk is based on joint work with Jack Koolen.

The position of classified edges due to the change in multiplicity of an eigenvalue in a tree

Kenji Toyonaga

National Institute of Technology, Kitakyushu College, Japan

We investigate the change in multiplicity of an eigenvalue based upon changes in edge values around a classified vertex in a tree. Then, we observe that a 2-Parter edge, a Parter edge and a downer edge are located separately each other in a tree, and there is a neutral edge between them. Especially, we show that the distance between a downer edge and a 2-Parter edge or a Parter edge is at least 2. We also consider a few relations between a downer edge and the value on a downer vertex.

Recent results on Q-polynomial association schemes

William J. Martin

Worcester Polytechnic Institute, USA

Over the past 20 years, the study of Q-polynomial (or "cometric") association schemes has come alive. Results of Suzuki, Williford, Suda, Van Dam, Muzychuk and others have greatly improved our understanding of the structure of cometric schemes and the important examples in this family. Yet many very simple questions remain unanswered. In this talk, I will give an update on the latest results and examples and will try to identify fundamental unresolved issues while making the argument that the subject is worthy of attention due to its connections to so many interesting areas.

A diagram associated with the subconstituent algebra of a distance-regular graph

Supalak Sumalroj

Silpakorn University, Thailand

In this paper we consider a distance-regular graph Γ. Fix a vertex x of Γ and consider the corresponding subconstituent algebra T. The algebra T is the $\mathbb{C}$-algebra generated by the Bose-Mesner algebra M of Γ and the dual Bose-Mesner algebra M^* of Γ with respect to x. We consider the subspaces $M, M^*, MM^*, M^*M, MM^*M, M^*MM^*, \ldots$ along with their intersections and sums. In our notation, MM^* means $Span\{RS | R \in M, S \in M^*\}$, and so on. We introduce a diagram that describes how these subspaces are related. We describe in detail that part of the diagram up to $MM^* + M^*M$. For each subspace U shown in this part of the diagram, we display an orthogonal basis for U along with the dimension of U. For an edge $U \subseteq W$ from this part of the diagram, we display an orthogonal basis for the orthogonal complement of U in W along with the dimension of this orthogonal complement.

Periodicities of Grover walks on distance-regular graphs

Yusuke Yoshie

Tohoku University, Japan

The Grover walk is a kind of widely studied quantum walks on graphs and it has been applied to various fields. It can be defined by a unitary evolution operator called the Grover transfer matrix. Recently,characterizations of classes of graphs to induce periodic Grover walks, that is, there exists an integer k such that the k-th power of the Grover transfer matrix becomes the identity matrix, has been studied. The distance-regular graphs are also widely studied graphs and it can be regarded as a generalization of the strongly regular graphs. In this talk, we focus on the periodicity of the Grover walks on distance-regular graphs and find some classes of such distance-regular graphs. Also, we obtain some necessary conditions to induce periodic Grover walks on the general distance-regular graphs.

Spectral analysis on the positive support of n-th power of Grover walk on a large girth graph

Etsuo Segawa

Tohoku University, Japan

Quantum walks have curious behavior such as coexistence of opposite properties of localization and linear spreading comparing with random walks. These properties are observed by measurement of the complex valued amplitude with respect to the absolute value at a large enough time. On the other hand, we emphasize an importance of the information of also the phase of the amplitude. The temporal phase pattern sequence of the quantum walk on the one-dimensional lattice treated here provides an interesting regularity from a global view point. We showed that the problem of the positive support of the n-th power of the Grover walk on a large girth graph can be switched to the decode of this phase pattern. We can draw exactly the non-trivial support of poles of the zeta function induced by the positive support of the n-th power of the Grover walk. The poles are inherited from the eigenvalues of the adjacency matrix. The inherited way for each n are obtained by referring the phase at time n. This talk is based on joint work with N. Konno (Yokohama National University) and I. Sato (Oyama National College of Technology).

Number of 4-contractible edges in 4-connected graphs

Yoshimi Egawa

Tokyo University of Science, Japan

Let G be a graph, and let $e \in E(G)$. We let G/e denote the graph obtained from G by contracting e into one vertex. When G is 4-connected, we say that G is 4-contractible if G/e is 4-connected, and we let $E_c(G)$ denote the set of 4-contractible edges of G. It is known that if G is a 4-connected graph, then $|E_c(G)| \geq (\sum_{x \in V(G)}(\deg(x) - 4))/68$. We improve this inequality by showing that if G is a 4-connected graph, then $|E_c(G)| \geq (\sum_{x \in V(G)}(\deg(x) - 4))/28$.

On a cluttered ordering for a bipartite graph

Tomoko Adachi

Toho University, Japan

A cluttered ordering is a type of a cyclic ordering of the complete bipartite graph. Mueller et al. (2005) decomposed the complete bipartite graph into isomorphic copies of the special bipartite graph $H(h;t)$, where h and t are positive integers. Adachi (2017) defined the special bipartite graph $H(h,k;t)$, which is extension of $H(h;t)$. $H(h;t)$ is the complete bipartite graph, but $H(h,k;t)$ is not. In this talk, we present some results on a cluttered ordering of a bipartite graph $H(h,k;t)$.

Domination in prism graphs

Monika Rosicka

University of Gdańsk, Poland

For a given graph $G = (V,E)$ and permutation $\pi : V \mapsto V$ the prism πG of G is defined as follows: $V(\pi G) = V(G) \cup V(G')$, where G' is a copy of G, and $E(\pi G) = E(G) \cup E(G') \cup M_\pi$, where $M_\pi = \{uv' : u \in V(G), v = \pi(u)\}$ and v' denotes the copy of v in G'. The graph G is called a universal fixer if its domination number satisfies $\gamma(\pi G) = \gamma(G)$ for every permutation π of $V(G)$.

In 2009 Mynhardt and Xu introduced the universal fixer conjecture, which states that the only universal fixers are edgeless graphs $\overline{K_n}$. In this talk we present a constructive proof of this conjecture, as well as some results concerning other types of domination in prism graphs, particularly convex and weakly convex domination.

Rainbow and Properly Colored Spanning Subgraphs

Yangyang Cheng

Shandong University, China

In this talk, we introduce the two recent works about rainbow and properly edge-colored spanning subgraphs in edge-colored graphs. In fact, we prove that every strongly edge-colored graph with minimum degree $\delta > \frac{2|G|-1}{3}$ has a rainbow hamiltonian cycle and every edge-colored connected graph with $\delta^c(G) \geq \frac{|G|}{2}$ has a properly colored spanning tree. This talk is based on joint work with Guanghui Wang(Shandong University) and Mikio Kano(Ibaraki University).

On mutually 3-orthogonal diagonal cubes

Xiao-Nan Lu

Tokyo University of Science, Japan

A d-cube (simply, a cube, when $d = 3$) of order n and type t ($0 \leq t \leq d-1$) is an $n \times n \times \cdots \times n$ (d times) array on n symbols, such that each symbol occurs exactly n^{d-t-1} times in every $(d-t)$-dimensional subarray obtained by fixing t coordinates. A set of d d-cubes is d-orthogonal, if when superimposed, each of the n^d ordered d-tuples appears exactly once. Furthermore, if each of the 2^{d-1} diagonals of a d-cube contains no repeated symbols, the d-cube is called diagonal. When $d = 2$ and $t = 1$, these are well known as (diagonal) Latin squares and their orthogonality.

In this talk, we consider the cases when $d = 3$ and present some constructions on mutually 3-orthogonal diagonal cubes. This talk is based on joint work with Tomoko Adachi (Toho University, Japan).

On Open Neighborhood Locating-Dominating Set of Mycielski Graphs

Suhadi Wido Saputro

Bandung Institute of Technology, Indonesia

A monitored system can be modelled as a graph G. It is generally assumed that a detection device located at vertex v in G, can detect an intruder only if the intruder is at v or at a vertex which is adjacent fo v. The placing monitoring device in the system can be considered as an open neighborhood locating-dominating problem. An open neighborhood locating-dominating set (OLD-set) S in a graph G is a vertex set of G such that for every vertex v in G, its open neighborhood has a unique non-empty intersection with S. The minimum cardinality of an OLD-set of G is called as the open neighborhood locating-dominating number of G, denoted by $OLD(G)$. In this paper, we consider a Mycielski graph of G, denoted by $\mu(G)$. For any connected graphs G, we determine the relation between $OLD(\mu(G))$ with $OLD(G)$, order of G, or the maximum degree of G. This talk is based on joint work with Wedyata Larasartika (Bandung Institute of Technology).

Some Rainbow Turán Problems for Hypergraphs

Qiancheng Ouyang

Shandong University, P. R. China

For a fixed hypergraph $\mathcal{H}$, the rainbow Turán number $ex_r^*(n, \mathcal{H})$ is the maximum number of edges in a r-uniform hypergraph on n vertices that has a proper edge-colouring with no rainbow $\mathcal{H}$. We study the rainbow Turán problem for some simple hypergraphs such as matchings, paths, and cycles. This talk is based on joint work with Guanghui Wang (Shandong University).

Codes with Rank-Metric and Matroids

Keisuke Shiromoto

Kumamoto University, Japan

A (Delsarte) *rank-metric code* of size $n \times m$ over a finite field $\mathbb{F}_q$ is an $\mathbb{F}_q$-linear subspace of the $n \times m$ matrix space $\mathrm{Mat}(n \times m, \mathbb{F}_q)$ over $\mathbb{F}_q$. A (q, k)-*polymatroid* is a q-analogue of k-polymatroids, and is defined by an ordered pair $\mathcal{M}_q = (E, \rho)$ consisting of $E := \mathbb{F}_q^n$ and a function $\rho : \mathcal{S}_n \to \mathbb{Z}^+ \cup \{0\}$ having the following properties:

(R1) If A is a subspace of E, then $0 \leq \rho(A) \leq k \dim A$.

(R2) If A, B are subspaces of E and $A \subseteq B$, then $\rho(A) \leq \rho(B)$.

(R3) If A, B are subspaces of E, then $\rho(A + B) + \rho(A \cap B) \leq \rho(A) + \rho(B)$.

In this talk, we show a relationship between a rank-metric code over a finite field and a (q, k)-polymatroid. We give a Greene type identity for the rank generating function of these polymatroids and the rank weight enumerator of these codes. Finally, we prove a MacWilliams type identity on codes with rank metric.

Forbidden subgraphs for constant domination number

Michitaka Furuya

Kitasato University, Japan

For a graph G, we let $\gamma(G)$ denote the *domination number* of G. For a set $\mathcal{H}$ of graphs, a graph G is $\mathcal{H}$-*free* if G contains no member of $\mathcal{H}$ as an induced subgraph. In this talk, we characterize the sets $\mathcal{H}$ of connected graphs such that there exists a constant $c = c(\mathcal{H})$ satisfying $\gamma(G) \leq c$ for every connected $\mathcal{H}$-free graph G.

The solution-attractor theory of local search system: the traveling salesmen problem case

Weiqi Li

University of Michigan-Flint, United States

In my talk I address one question - Can the Traveling Salesman Problem (TSP) be solved by a brute-force search algorithm efficiently? Local search is a widely-used search technique. Attractor theory in dynamical systems provides the necessary and sufficient theoretical foundation to study search behavior of local-search systems. I will introduce the solution-attractor theory of local search system for TSP. Search trajectories in a local search system converge into a small region, called solution attractor. The solution attractor not only provide a model to describe the search behavior, but also offer a method to solve TSP efficiently with optimality guarantee.

On p-frame potential of random point configurations on the sphere

Masatake Hirao

Aichi Prefectural University, Japan

In this talk we deal with two types of random point configurations, determinantal point process and the jittered sampling on the sphere. Determinantal point processes are random point processes, which are used in a fermion model in quantum mechanics. Jittered sampling is one of the famous random sampling method using uniformly distribution on each divided subspaces. We compare these random point configurations and spherical designs which are deterministic point configurations on the sphere in the viewpoint of p-frame potential. We also discuss some applications of these point configurations on the sphere if possible.

On the Recognition of Unit Grid Intersection Graphs

Satoshi Tayu

Tokyo Institute of Technology, Japan

A graph is called an intersection graph if there exists a set of objects such that each vertex corresponds to an object and two vertices are adjacent if the corresponding objects intersect. A unit grid intersection graph is an intersection graph such that every object is a horizontal or vertical line segment, no two parallel segments intersect, and every segment has the same length. In this talk we show that it is NP-complete to determine whether a given graph is a unit grid intersection graph. This talk is based on joint work with Shuichi Ueno (Tokyo Institute of Technology).

Spherical embeddings of symmetric association schemes

Da Zhao

Shanghai Jiao Tong University, China

In this talk we present some results on spherical embeddings of symmetric association schemes. We give the classification of faithful spherical embeddings of symmetric association schemes in 3-dimensional Euclidean space, a bound of the girth of a Q-polynomial association scheme assuming an intersection number being 1, and apply it to the faithful spherical embeddings of primitive Q-polynomial association schemes in 4-dimensional Euclidean space. This talk is based on joint work with Eiichi Bannai (Shanghai Jiao Tong University) and Attila Sali (Hungarian Academy of Sciences).

The Nature Diagnosability of Bubble-sort Star Graphs under the PMC Model and MM^* Model

Mujiangshan Wang

The University of Newcastle, China, Australia

Many multiprocessor systems have interconnection networks as underlying topologies and an interconnection network is usually represented by a graph where nodes represent processors and links represent communication links between processors. No fault set can contain all the neighbors of any fault-free vertex in the system, which is called the nature diagnosability of the system. Diagnosability of a multiprocessor system is one important study topic. As a famous topology structure of interconnection networks, the n-dimensional bubble-sort star graph BS_n has many good properties. In this paper, we prove that the nature diagnosability of BS_n is $4n-7$ under the PMC model for $n \geq 4$, the nature diagnosability of BS_n is $4n-7$ under the MM^* model for $n \geq 5$. This talk is based on joint work with Yuqing Lin (The University of Newcastle).

Classification problem of certain spherical embeddings of strongly regular graphs

Eiichi Bannai

Japan

Generalizing the concept of spherical t-design, for a subset T of positive integers, we say that a finite subset X on the unit sphere S^{n-1} is a spherical T-design, if $\sum_{x\in X} f(x) = 0$ for any homogeneous harmonic polynomials $f(x) = f(x_1, x_2, \ldots, x_n)$ of degree i with $i \in T$. In this paper we try to classify such X which is a 2-distance set and a spherical $\{4, 2, 1\}$-design. We can determine all possible parameters (there are two infinite families) for them. Namely, X must be either a tight spherical 4-design on S^{n-1} with $|X| = n(n+3)/2$ or a half of a tight spherical 5-design on S^n with $|X| = (n+1)(n+2)/2$. (It is still open which of them actually exist.) The key point is to drive a certain very involved diophantine equation and then solve the integer solutions of it completely, by the systematic use of computer.
This talk is joint work with Etsuko Bannai, Ziqing Xiang (University of Geogia), Wei-Hsuan Yu (Brown University), Yan Zhu (Shanghai University).

A Polynomial Time Algorithm to Compute Geodesics in CAT(0) Cubical Complexes

Koyo Hayashi

University of Tokyo, Japan

In this talk we present a polynomial time algorithm to compute geodesics in a CAT(0) cubical complex in general dimension. The algorithm is a simple iterative method to update breakpoints of a path joining two points using Miller, Owen and Provan's algorithm (2015) as a subroutine. Our algorithm is applicable to any CAT(0) space in which geodesics between two close points can be computed, not limited to CAT(0) cubical complexes.

Solving Feedback Vertex Set via Half-Integral Relaxation

Yoichi Iwata

National Institute of Informatics, Japan

In this talk, we present a $(4^k + |E|)k^{O(1)}$-time FPT algorithm for Feedback Vertex Set, where k is the solution size. A solver based on this algorithm won 1st place in the Parameterized Algorithms and Computational Experiments (PACE) challenge 2016. Our algorithm exploits half-integral relaxation, a powerful tool in the design of FPT algorithms. We first introduce a key property called persistency and then obtain an $O^*(4^k)$-time FPT algorithm and an $O(k^2)$-size kernel. Finally, we present a linear-time augmenting path algorithm for solving the half-integral relaxation.

Cheeger Inequalities for Submodular Transformations

Yuichi Yoshida

National Institute of Informatics, Japan

The Cheeger inequality for undirected graphs, which relates the conductance of an undirected graph and the second smallest eigenvalue of its normalized Laplacian, is a cornerstone of spectral graph theory. The Cheeger inequality has been extended to directed graphs and hypergraphs using normalized Laplacians for those, that are no longer linear but piecewise linear transformations. In this paper, we introduce the notion of a submodular transformation $F : \{0, 1\}^n \to \mathbb{R}^m$, which applies m submodular functions to the n-dimensional input vector, and then introduce the notions of its Laplacian and normalized Laplacian. With these notions, we unify and generalize the existing Cheeger inequalities by showing a Cheeger inequality for submodular transformations, which relates the conductance of a submodular transformation and the smallest non-trivial eigenvalue of its normalized Laplacian. This result recovers the Cheeger inequalities for undirected graphs, directed graphs, and hypergraphs, and derives novel Cheeger inequalities for mutual information and directed information. Computing the smallest non-trivial eigenvalue of a normalized Laplacian of a submodular transformation is NP-hard under the small set expansion hypothesis. In this paper, we present a polynomial-time $O(\log n)$-approximation algorithm for the symmetric case, which is tight, and a polynomial-time $O(\log^2 n + \log n \cdot \log m)$-approximation algorithm for the general case. We expect the algebra concerned with submodular transformations, or submodular algebra, to be useful in the future not only for generalizing spectral graph theory but also for analyzing other problems that involve piecewise linear transformations, e.g., deep learning.

Complexity of the Multi-Service Center Problem

Naonori Kakimura

Keio University, Japan

The multi-service center problem is a variant of facility location problems. In the problem, we consider locating p facilities on a graph, each of which provides distinct service required by all vertices. Each vertex incurs the cost determined by the sum of the weighted distances to the p facilities. The aim of the problem is to minimize the maximum cost among all vertices. This problem was known to be NP-hard for general graphs, while it is polynomially solvable when p is a fixed constant. In this paper, we give sharp analyses for the complexity of the problem from the viewpoint of graph classes and weights on vertices. We first propose a polynomial-time algorithm for trees when p is a part of input. In contrast, we prove that the problem becomes strongly NP-hard even for cycles. We also show that when vertices are allowed to have negative weights, the problem becomes NP-hard for paths of only three vertices and strongly NP-hard for stars.

This talk is based on joint work with Takehiro Ito (Tohoku University) and Yusuke Kobayashi (University of Tsukuba).

Rectangular Matrix Multiplication: Overview of Recent Progress

François Le Gall

Kyoto University, Japan

In the past few years, successive improvements on the asymptotic complexity of square matrix multiplication have been obtained by developing novel methods to analyze the powers of the "Coppersmith-Winograd tensor", a basic construction introduced thirty years ago. In the first part of my talk I will briefly survey these recent developments. In the second part of the talk, which is based on a recent joint work with Florent Urrutia, I will describe how to generalize this approach to make progress on the complexity of rectangular matrix multiplication as well, and then discuss some applications and some open problems.

A graph-theoretic construction of Dihedral quadruple systems and its countable analogue

Masanori Sawa

Kobe University, Japan

From the late 1970s to the early 1980s, Egmont Kőhler developed a theory for constructing finite quadruple systems with point-transitive Dihedral automorphism groups by introducing a certain algebraic graph, now widely known as the (first) Kőhler graph in finite combinatorics. In this talk we introduce the *countable Kőhler graph* and discuss countable extensions of a series of Kőhler's works, with emphasis on various gaps between the finite and countable cases. We show that there is a simple 2-fold quadruple system over $\mathbb{Z}$ with a point-transitive Dihedral automorphism group if the countable Kőhler graph has a so-called $[1,2]$-factor originally introduced by Kano (1986) in the study of finite graphs. We also prove that a simple Dihedral ℓ-fold quadruple system over $\mathbb{Z}$ exists if and only if $\ell = 2$.

Infinite structures with finite VC$_n$-dimension

Kota Takeuchi

University of Tsukuba, Japan

In model theory, we often talk about "tameness" of infinite structures. No Independent Property (NIP) is a kind of such tameness. A (binary) relation in a structure said to be NIP if it does not define a complicated class of subsets of the structure in Model theoretic sense. It is well known that a relation is NIP if and only if the family of subsets defined by the relation has finite Vapnik-Chervonenkis (VC) dimension. Moreover, the number of orbits under a specific automorphism group, which is called the number of types in model theory, coincides with the value of the shatter function in combinatorics. In 2009, Shelah introduced a generalization of the notion of NIP—NIP$_n$ for n-ary relations, and then asked the upper bound of the number of types in NIP$_n$ structures. The speaker and several model theorists answered this question by defining VC$_n$-dimension and generalizing Sauer-Shelah lemma to such situation. Since VC-dimension appears in many field of mathematics, it is expected that the notion of VC$_n$-dimension suggests new interests of study in such fields. In this talk I'd like to introduce about basic results and recent topics on VC$_n$-dimension.

On a Fraïssé-style construction of a countable universal homogeneous graph

Koichiro Ikeda

Hosei University, Japan

In 1980's, Ehud Hrushovski modified Fraïssé's construction of a universal homogeneous countable relational structure from the class of its finite substructures, in order to obtain counter-examples to well-known conjectures in model theory. His construction has been applied to various fields other than model theory. In this talk, we will introduce some relations between zero-one law and the Hrushovski construction.

On countable graphs generated by classes of finite graphs

Shunsuke Okabe

Kobe University, Japan

The random graph, especially the Rado graph is very symmetric. Since the Rado graph contains all finite graphs, it is the significant object connecting the countable combinatorics and the finite combinatorics. In model theory, the Rado graph is one of the generic graphs having "special" properties, and we study generic structures the analogues of the generic graphs. In this talk, we will introduce the properties of the classes of finite graphs having the generic graphs and talk on the generalization to other structures.

Adjacency properties of graphs analogous to the countable random graph, their links with combinatorial designs and arrays

Xiao-Nan Lu

Tokyo University of Science, Japan

It was proved by Erdős and Rényi in 1963 that there is a unique *countably infinite random graph*. Meanwhile, in the same work, adjacency properties of (finite) graphs, which are analogue to the countable random graph, were investigated as well. Roughly speaking, an *adjacency property* of a graph asserts that for any set S_1 of vertices of the graph, there is another set S_2 of vertices, such that the edges between S_1 and S_2 are joined in some prescribed manner.

In this talk, I will focus on the so-called *n-existentially closed* (n-ec) property and its generalization called the *n-separably existentially closed* (n-sec) property. Let G be a (finite, simple, undirected) graph with vertex set V. Let $N(A;B)$ denote the set of all the vertices which are adjacent to every vertex in A but no vertex in B for disjoint $A, B \subseteq V$. Let n be a positive integer. If $N(A;B) \neq \emptyset$ for any pair of disjoint $A, B \subseteq V$ (possibly empty) with $|A \cup B| = n$, the graph G is said to be n-ec. Moreover, if $N(A;B)$'s never coincide for different choices of (A, B), then G is said to be n-sec.

A main focus of (finite) combinatorics, in particular, design theory, is the incidence structures with nice balanced properties and strong symmetries. These incidence structures can be represented by set systems (a finite set together with a family of its subsets) or combinatorial arrays (a matrix with entries from a finite set of symbols). In this talk, I will introduce some relation between n-ec graphs, n-sec graphs, and such incidence structures. In particular, I will propose some recent approaches on the block intersection graphs of designs which give rise to n-ec graphs.

Applications of adjacency properties from the countable random graph to graph-theoretic problems

Shohei Satake

Kobe University, Japan

Let l and m be non-negative integers such that $l + m$ is positive. A graph G satisfies the adjacency property $\mathcal{P}(l, m)$ if for any disjoint subsets of vertices A and B such that $|A| = l$ and $|B| = m$, there exists a vertex $z \notin A \cup B$ such that z is adjacent to all vertices of A, but none of B. These properties come from the countable random graph R (or the Rado graph) introduced by Erdős-Rényi (1963) and Rado (1964). Actually, R is defined as the (unique) countable graph satisfying $\mathcal{P}(l, m)$ for all l and m. In finite graph theory, the constructing problem of graphs with these adjacency properties has been researched by many researchers, for example, Blass-Exoo-Harary (1981), Cameron-Stark (2002) and Bonato (2009). One of the famous solutions is the Paley graph G_q, the graph whose vertex set is the finite field $\mathbb{F}_q$ with q elements in which two vertices x and y are adjacent if $x - y$ is a non-zero square in $\mathbb{F}_q$. Here q should be a prime power such that $q \equiv 1 \pmod 4$.

In this talk, by focusing adjacency properties, we discuss the clique number, the maximal size of complete subgraphs, of G_p for primes $p \equiv 1 \pmod 4$, which has been investigated in graph theory or algebraic combinatorics. Moreover, we also apply to a similar problem in combinatorial number theory and its generalization.

Closure for $\{K_{1,4}, K_{1,4}+e\}$-free graphs

Zdeněk Ryjáček

University of West Bohemia, Czech Republic

We introduce a closure concept for hamiltonicity in the class of $\{K_{1,4}, K_{1,4}+e\}$-free graphs, extending the closure for claw-free graphs. The closure of a $\{K_{1,4}, K_{1,4}+e\}$-free graph with minium degree at least 6 is uniquely determined, is a line graph of a triangle-free graph, and preserves its hamiltonicity or non-hamiltonicity. As applications, we show that many results on claw-free graphs can be directly extended to the class of $\{K_{1,4}, K_{1,4}+e\}$-free graphs. Joint work with Shipeng Wang (Beijing Institute of Technology) and Petr Vrána (University of West Bohemia).

On extremal mixed graphs

James Tuite

Open University, United Kingdom

A topic of interest in extremal graph theory is the optimisation of the order of a network subject to restraints on parameters such as maximum degree, diameter, girth, connectivity, etc. Recently such problems have been studied in the context of mixed graphs, i.e. networks that contain both directed arcs and undirected edges. In the setting of the degree/diameter problem and a new mixed analogue of the degree/girth problem, I will present new bounds on the order of mixed graphs, together with results on the structure of extremal graphs and methods of construction. This represents joint work with Dr Grahame Erskine (Open University).

Degree powers in graphs with a forbidden forest

Henry Liu

Sun Yat-sen University, China

For a graph G with degree sequence $d_1, \dots, d_n$, and for a positive integer p, let $e_p(G) = \sum_{i=1}^{n} d_i^p$. In 2000, Caro and Yuster [A Turán type problem concerning the powers of the degrees of a graph, Electron. J. Combin. 7 (2000), R47] introduced the following Turán type problem: *Given a positive integer p and a graph H, determine the function $\mathrm{ex}_p(n, H)$, which is the maximum value of $e_p(G)$ taken over all graphs G on n vertices that do not contain H as a subgraph.* Obviously, we have $\mathrm{ex}_1(n, H) = 2\mathrm{ex}(n, H)$, where $\mathrm{ex}(n, H)$ denotes the classical Turán function. Previous results on this problem, obtained by various authors, include the determination of the function $\mathrm{ex}_p(n, H)$ when H is a complete graph, a cycle, a path, and a star. In this talk, we shall present some new results for the function $\mathrm{ex}_p(n, H)$ when H is a certain type of forest, namely, a linear forest, a star forest, and a broom (i.e., a path with a star at one end). This talk is based on joint work with Yongxin Lan (Nankai University), Zhongmei Qin (Chang'an University) and Yongtang Shi (Nankai University).

Results related to structures in Gallai colorings

Roman Čada

University of West Bohemia, Czech

In this talk we deal with some structural properties related to Gallai colorings, especially in relationship with Ramsey-type problems and the existence of monochromatic cliques in such colorings.

Every 4-connected graph with crossing number 2 is hamiltonian

Kenta Ozeki

Yokohama National University, Japan

Tutte showed that every 4-connected planar graph contains Hamiltonian cycle, and this result has been extended to mainly graphs on non-spherical surfaces. In this talk, we focus on the extension in terms of crossing number, and prove every 4-connected graph with crossing number 2 is hamiltonian. We further discuss the best possibility of the condition crossing number 2. This talk is based on joint work with Carol Zamfirescu (Ghent University).

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