Welcome to IPM

On behalf of the School of Mathematics of IPM, it is a great pleasure and honor to welcome you to

IPM Combinatorics and Computing Conference 2017
(IPMCCC 2017).

We would like to thank our distinguished speakers and visitors who have made this meeting possible.

Also we would like to express our special thanks to the organizing committee for their efforts without which organizing the conference would be impossible.

We hope that this meeting will contribute to the development of research in this area and enhance communication with our colleagues throughout the world.

We wish that you find IPM and the general atmosphere in Iran cordial and this meeting will serve as a very small step in the promotion of international understanding as well.

Have a great visit!

School of Mathematics,
IPM

About IPM and its School of Mathematics

The Institute for Research in Fundamental Sciences (IPM) is an institute affiliated with the Ministry of Science, Research, and Technology. It was founded in 1989 under the name "Institute for Studies in Theoretical Physics and Mathematics" and its initial goal was the advancement of research and innovation in theoretical physics and mathematics. The foundation of the Institute was also accompanied by hopes and expectations that a model would be developed which could serve as a basis for the promotion of the culture of research all across the country.

The Institute started its activities with three research groups in physics and three research groups in mathematics (Combinatorics and Computing, Dynamical Systems, and Mathematical Logic & Theoretical Computer Science). Initially it had few researchers and limited resources, but gradually it managed to expand its manpower in physics and mathematics, and it also attracted scientists from other disciplines. The activities of the Institute thus extended to other fields and in 1997 it acquired its present name. The Institute now consists of nine schools: Analytic Philosophy, Astronomy, Biological Sciences, Cognitive Sciences, Computer Science, Mathematics, Nano-Science, Particles and Accelerator, and Physics. It enjoys an expanding base of infrastructures and facilities (electronic networking, computers, laboratories, a well-equipped and up-to-date library), and has an active presence in the national research activities within the corresponding fields.

The School of Mathematics (formerly called the Section of Mathematics) has been one of the founder schools of IPM. Presently, there are five main research areas at the School:
Analysis, Combinatorics and Computing, Commutative Algebra, Geometry and Topology, and Mathematical Logic. Different research modalities are available at the School of Mathematics: Founding Fellows, Faculty Members, Postdoctoral Research Fellows, Senior Associate Researchers, Junior Associate Researchers, Non-resident Researchers, and Student Researchers in full-time, part-time, and non-resident modes.

About IPMCCC 2017

The IPM Combinatorics and Computing Conference 2017 (IPMCCC 2017) is the second conference in a series organized by the Combinatorics and Computing Group of IPM. The purpose of the IPMCCCs is to bring together researchers interested in all areas of Combinatorics and Theoretical Computer Science, to discuss the latest developments and findings in their areas, take stock of what remains to be done and explore different visions for setting the direction for future work.

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Invited Speakers

Meysam Alishahi (Shahrood University of Technology, Iran)
Michel Habib (Paris 7, France)
Mohammadtaghi Hajiaghayi (University of Maryland, College Park, USA)
Ramin Javadi (Isfahan University of Technology, Iran)
Jonathan Jedwab (Simon Fraser University, Canada)
Ebadollah Mahmoodian (Sharif University of Technology, Iran)
Reza Naserasr (LRI, France)
Farzad Parvaresh (University of Isfahan, Iran)
Mathias Schacht (University of Hamburg, Germany)

Program at a Glance

	Tuesday May 16	**Wednesday May 17**	**Thursday May 18**
8:15-8:45	Registration		
8:45-9:00	Welcoming Remarks		
9:00-10:00	Habib	Mahmoodian	Schacht
10:00-10:30	Break	Break	Break
10:30-11:30	Naserasr	Jedwab	Javadi
11:30-11:50	Raeisi	Khodkar	Stones
11:50-12:10	Maherani	Ghameshlou	Taleb
12:10-12:30	Farrokhi	Kazemi	Abyazi
12:30-12:50	Lunch	Group Photo	Jazaeri
12:50-14:00		Lunch	Lunch
14:00-15:00	Hajiaghayi	Alishahi	
15:00-15:30	Break	Break	
15:30-15:50	Parvaresh	Nassaj	
15:50-16:10		Gholami	
16:10-16:30		Amirzadeh	
16:40-17:00	Khodaiemehr	Behmaram	
17:00-17:20	Ardalan	Ghareghani	
17:20-17:40	Alimadadi	Oboudi	
17:40-18:00	Dolati	Nahvi	
19:00-20:00		Conference Dinner	

Abstracts of the Talks

(In Alphabetical Order)

Invited Speakers

Hypergraphs Coloring via Tucker Lemma

Meysam Alishahi
Shahrood University of Technology, Iran

In a break-through, Lovász in 1978 determined the chromatic number of Kneser graphs $\mathrm{KG}(n,k)$ and solved a long-standing conjecture posed by Kneser in 1955. His proof gave birth to an area of combinatorics which nowadays is known as the topological combinatorics. As a main object, this area of combinatorics focuses on studying the coloring properties of graphs and hypergraphs by using algebraic topological tools. There are many results investigating the coloring properties of Kneser graphs proved by using the Borsuk-Ulam theorem. A combinatorial counterpart of the Borsuk-Ulam theorem is the Tucker lemma. Matoušek proved the Lovász-Kneser theorem by use of the Tucker lemma. Since the Tucker lemma can be proved purely combinatorial, any proof using the Tucker lemma (or some of its generalizations) is known as a combinatorial proof.

This talk presents a survey on some existing as well as new trends in the field of topological combinatorics respecting to the hypergraphs coloring properties. In this regard, we first review some well-known results due to Lovász (1978), Alon, Frankl, and Lovász (1986), Dol′ nikov (1988), Kříž (1992), Simonyi and Tardos (2006), and Chen (2011). Then, we present some generalizations of these results. The proofs of these generalizations rely on the use of the Tucker lemma or some appropriate generalizations of it.

This is a joint work with H. Hajiabolhassan and F. Meunier.

Comparability Graphs and Greedy Algorithms

Michel Habib
IRIF, CNRS & Universit Paris Diderot, Paris, France

A cocomparability graph is a graph whose complement admits a transitive orientation. An interval graph is the intersection graph of a family of intervals on the real line. In this paper we investigate the relationships between interval and cocomparability graphs. I will first present some recent search-based algorithms we obtained on cocomparability graphs [1,2]. They show that for some problems, the algorithm used on interval graphs can also be used with small modifications on cocomparability graphs. Many of these algorithms are based on graph searches that preserve cocomparability orderings.

Then I will propose a characterization of cocomparability graphs via a lattice structure on the set of their maximal cliques. This characterization also has interesting algorithmic consequences and we show that a new graph search, namely Local Maximal Neighborhood

Search (LocalMNS) leads to an $O(n + mlogn)$ time algorithm to find a maximal interval subgraph of a cocomparability graph. Similarly I propose a linear time algorithm to compute all simplicial vertices in a cocomparability graph. In both cases we improve on the current state of knowledge.

It appears that all the algorithms presented here, come from a unique greedy algorithmic skeleton. I will finish by exhibiting some other applications of this framework.

References

[1] Derek G. Corneil, Jéeémie Dusart, Michel Habib, and E. Köhler. On the power of graph searching for cocornparability graphs. *SIAM J. Discrete Math.*, 30(1):569-591, 2016.

[2] Jéeémie Dusart and Michel Habib. A new LBFS-based algorithm for cocomparability graph recognition. *Discrete Applied Mathematics*, 216:149-161, 2017.

Algorithm Design with Knowledge: Secretaries and Prophets

Mohammadtaghi Hajiaghayi
University of Maryland, College Park, USA

In this talk we consider more efficient algorithm design when we have some knowledge about the input instance. Knowledge such as structure of the input or input distributions can be used to design more efficient algorithms especially for practical scenarios. This is in contrast to the worst case analysis that hardly may happen in real-world.

To give examples of such algorithms, in particular we consider two popular versions of online selection problems - secretary problems and prophet inequalities. In both of these problems, elements of a set are revealed one at a time and we have some knowledge about the distribution of the input. When an element is revealed, we must immediately and irrevocably decide whether to accept, but forgoing the opportunity to see the remaining elements, or reject, bypassing the element forever (but we still see future elements). We cover several extensions of these popular online selection problems in computer science which are mainly followups of two pioneering works of the speaker.

The Structure of Claw-free Graphs and their Edge Clique Covering

Ramin Javadi
Isfahan University of Technology, Iran

This talk is focused on claw-free graphs, i.e. graphs with no induced $K_{1,3}$ subgraphs. A seminal work of Maria Chudnovsky and Paul Seymour in 2005 gives a theorem which thoroughly describes the structure of these graphs. The structure theorem essentially states that all claw-free graphs can be obtained by a number of operations from some basic classes of graphs. Through a decade, this theorem has been successfully deployed to

prove many conjectures on claw-free graphs. In this talk, first we give a brief introduction to this theorem and its consequences. Then, we concentrate on a conjecture related to edge clique covering of claw-free graphs. This conjecture sates that the edge set of every claw-free graph on n vertices can be covered by at most n of its cliques. We will elaborate on how the structure theorem can be applied to prove this conjecture for all claw-free graphs with independence number at least three. We also consider the claw-free graphs with independence number at most two (i.e. the complement of triangle-free graphs) and explain some approaches to attack the conjecture for these graphs. Finally, we will discuss about the equality cases as well as some generalizations and open problems. Some presented new results are based on my recent joint work with Sepehr Hajebi.

A Strong External Difference Family with More than Two Subsets

Jonathan Jedwab
Simon Fraser University, Canada

Strong external difference families (SEDFs) were introduced by Paterson and Stinson as a more restrictive version of external difference families. SEDFs can be used to produce optimal strong algebraic manipulation detection codes. We characterize the parameters (v, m, k, λ) of a nontrivial SEDF that is near-complete (satisfying $v = km + 1$). We construct the first known nontrivial example of a (v, m, k, λ) SEDF having $m > 2$ subsets. The parameters of this example are $(243, 11, 22, 20)$, giving a near-complete SEDF, and its group is $\mathbb{Z}_3^5$. The construction uses the point-orbits of the Mathieu group M_{11} acting on the projective geometry $\mathrm{PG}(4, 3)$.

This is joint work with Shuxing Li.

Linear Algebraic Approach to: Combinatorial Designs

Ebad S. Mahmoodian
Sharif University of Technology, Iran

An important question is uniformly generating combinatorial designs such as: Latin squares, STSs, block designs, Sudokus, k-cycle Systems, and etc. By simulating an ergodic Markov chain whose stationary distribution is uniform over the space of $n \times n$ Latin squares, Mark T. Jacobson and Peter Matthews [1996], have discussed elegant methods by which they generate Latin squares with a uniform distribution (approximately). The central issue is the construction of "moves" that connect the squares.

Looking at Latin squares by a linear algebraic approach makes their move very clear and we end up with a short proof of their main statement. Linear algebraic approach to block designs has been around for a long time. We continue this look for other cases such as Latin squares, Sudokus, 4-cycle systems.

In each case we define an "inclusion matrix" and find its rank and a basis for its null space consisting of "minimal trades" (or Latin intercalates, Sudoku intercalates, double

diamonds, etc.). Also in each case we show that there is a straight forward algorithm for writing each trade as a sum of these minimal trades.

This is joint work with A. Khanban, M. Mahdian, Diane M. Donovan, M. Aryapour, J. Cooper, Rafieh Mosaheb, Maryam Khoravi, and Saeedeh Rashidi.

Bounding Partial t-Trees in Homomorphism Order

Reza Naserasr
LRI, France

In this talk I will present a necessary and sufficient condition for a graph B of odd-girth $2k+1$ to admit a homomorphism from any partial t-tree of odd-girth at least $2k+1$. As an application we prove that any partial 3-tree of odd-girth $2k+1$ admits a homomorphism to the projective cube of dimension $2k$, that is the Caley graph $(\mathbb{Z}_2^{2k}, \{e_1, e_2, \cdots e_{2k}, J\}$ where e_i's are the standard basis and J is the all-1 vector. This supports a conjecture in generalization of the four-color theorem which claims that every K_5-minor free graph of odd-girth at least $2k+1$ admits a homomorphism to the projective cube of dimension $2k$.

This is a joint work with L. Beaudou, M. Chen and F. Foucaud.

Enumeration of Binary Matrices with Bounded Row and Column Sums

Farzad Parvaresh
University of Isfahan, Iran

Consider $n \times n$ binary matrices with the constraint that the number of ones in each row and column of the matrices are at most $n/2$. We show asymptotically there are $2^{n^2\rho n+\delta(n)\sqrt{n}}n^{O(1)}$ many such matrices, for a constant $\rho \approx 1.42515$ and $\delta(n) \approx 1.46016$ for even n and 0 otherwise. In this talk, we briefly review the work of Canfield et. al. that use saddle point techniques to count binary matrices with the prescribed row and column sums. Then, we provide a lower bound on the number of matrices that their prescribed row and column sums are at most $n/2$. To complete the proof, we use a switching technique to upper bound the number of desired matrices and we show that the computed lower bound is tight. We also provide some observations that using sum-product algorithms can estimate the number of binary matrices with bounded row and column sums with high accuracy despite the fact that the factor graph of the problem has many short cycles.

This is a joint work with E. Ordentlich, R. Roth and P. Vontobel.

Extremal Problems for Uniformly Dense Hypergraphs

Mathias Schacht
University of Hamburg, Germany

Extremal problems for hypergraphs concern the maximum density of large hypergraphs H that do not contain a copy of a given hypergraph F. Estimating the so-called Turán-densities is a central problem in combinatorics. However, despite a lot of effort precise estimates are only known for very few hypergraphs F. We consider a variation of the problem, where the large hypergraphs H satisfy additional hereditary density conditions. We present recent progress based on joint work with Reiher and Rödl. In particular, we established a computer-free proof of a recent result of Glebov, Král', and Volec on the Turán-density of the 3-uniform hypergraph with three edges on four vertices for hypergraphs that are hereditarily dense on large vertex sets.

Contributed Talks

An Improvement of Dolnikov-Kriz Lower Bound on the Chromatic Number of General Kneser Hypergraphs

Roya Abyazi Sani
Shahrood University of Technology, Iran

In a break-through, Lovász (1978) determined the chromatic number of Kneser graphs and solved a long-standing conjecture posed by Kneser (1955). His proof gave birth to an area of combinatorics which nowadays is known as the topological combinatorics. For the hypergraph $\mathcal{H}$, the general Kneser hypergraph $KG^r(\mathcal{H})$ is an r-uniform hypergraph with the vertex set $E(\mathcal{H})$ where each r pairwise disjoint edges of $\mathcal{H}$ form an edge of $KG^r(\mathcal{H})$. The general Kneser hypergraph is an important object in the topological combinatorics area involved in a series of works. Dolnikov (1988) (for $r = 2$) and Kriz (1992) provided a lower bound for the chromatic number of $KG^r(\mathcal{H})$ based on a combinatorial parameter associated to the hypergraph $\mathcal{H}$, the r-colorability defect of $\mathcal{H}$.

We here introduce an equitable version of colorability defect of hypergraphs. Applying this modified version of colorability defect, we propose a sharp lower bound for the chromatic number of $\mathrm{KG}^p(\mathcal{H})$ for the prime number p and generalize it to non-prime number r by a reduction inspired by Kriz (2000). We demonstrate that not only our proposed lower bound outperforms the Dolnikov-Kriz lower bound, but also the difference can be arbitrary large. Furthermore, the chromatic number of some family of graphs are determined by use of the aforementioned lower bound.

This is a joint work with M. Alishahi.

Parallel Knockout Procedure

Abdollah Alimadadi
Shahid Rajaee Teacher Training University, Iran

A parallel knockout procedure (PKP) is a vertex eliminating procedure which takes place in a given graph G through several rounds. In each round each vertex v with open neighborhood $N(v) \neq \emptyset$ designates a vertex $f(v) = w \in N(v)$ to be deleted. Such vertices are removed simultaneously. That is, G is reduced to $G - f(V(G))$. Parallel knockout rounds continue until the resulting graph is an independent set (totally disconnected). Hence, we can say, a parallel knockout procedure (PKP) of G is defined as follows : Start with $G = G_0$; each nonisolated vertex v in $V(G)$ designates a vertex in its open neighborhood $N(v_i)$; S_i is the set of designated vertices; and $G_{i+1} = G - S_i$. Let t be the smallest value for which G_t, has no edges. Then G_t is an independent set in G, and this set of vertices is called a terminating set. The associated PKP-sequence is $G = (G_0, G_1, G_2, ..., G_t)$. The lower and upper PKP number for G, $L_m(G)$, and $L_M(G)$

respectively, are the minimum and maximum possible values of $|V(G_t)|$ for a terminating set G_t. Let $L(G)$ denote the expected cardinality of the terminating set G_t, and for each $v \in V(G)$, let $L(v)$ denote the probability that v survives in G_t, so $L(G) = \sum_{v \in V(G)} L(v)$.

Various parameters involving the minimum number, expected number and maximum number of remaining vertices will be discussed.

Analytical Lower Bounds for the Size of Elementary Trapping Sets of Regular LDPC Codes

Farzane Amirzade
Shahrood University of Technology, Iran

In this paper we give lower bounds on the size of (a, b) elementary trapping sets (or simply ETSs) belonging to (γ, λ)-regular LDPC codes with any girth g, where a is the number of variable nodes and b is the number of degree-one check nodes and satisfy the inequality $\frac{b}{a} < 1$. In fact we prove that Tanner graph of a (γ, λ)-regular LDPC code with girth g contains no (a, b) ETS of size $a \leq 2\gamma - 2$, $a \leq (\gamma - 1)^k$ and $a \leq 2(\gamma - 1)^k$ for $g = 8$, $g = 4k + 2$ and $g = 4k + 4$, respectively. According to the literature, for $3 \leq \gamma \leq 6$ and $g = 6, 8$ the minimum size of (a, b) ETSs, where $\frac{b}{a} < 1$, are investigated. They are based on exhaustive search algorithms. But our proposed lower bounds are analytical and based on some well-known graph theories. Moreover, our results not only acknowledge the previous results but also they are generalized for all values of γ and g. Furthermore, some of our investigations on non-existence of (a, b) ETSs are independent of the girth of Tanner graph. They rely on the variables a, b and γ.

This is a joint work with Mohammad-Reza Sadeghi.

Evaluating Nondeterministic Signal Machine Relative Complexity: A Case Study on Dominating Set Problem

Sahar Ardalan
University of Tabriz, Iran

A signal machine is an abstract geometrical model of computation, which can be viewed as a continous space and time generalisation of cellular automata. Almost all studies that have been made are about deterministic signal machines. The present paper is one of the first studies that have been made on nondeterministic signal machines and it shows their high efficiency in solving problems using a well-known combinatorial problem. We provide a method to find the minimum graph dominating set using nondeterministic signal machines. First we show how to design a signal machine for each specific instance of the dominating set problem. Then we propose a signal machine which solves the dominating set problem for any instance of the problem, and show how to reduce the space complexity of solution using nondeterminism.

Perfect Matchings in m-Barrel Fullerene

Afshin Behmaram
University of Tabriz, Iran

A **matching** M in a graph G is a collection of edges of G such that no two edges of M share a vertex. If every vertex of G is incident to an edge of M, the matching M is called **perfect**. Perfect matchings have played an important role in the chemical graph theory, in particular for benzenoid graphs, where their number correlates with the compound's stability.let $\Phi(G)$ be the number of perfect matchings in G.

A **fullerene graph** is a cubic, planar, 3-connected graph with only pentagonal and hexagonal faces.Classical fullerene graphs have been intensely researched since the discovery of buckminsterfullerene in the fundamental paper [6], which appeared in 1985. This paper gave rise to the whole new area of fullerene science.

A connected 3-regular planar graph $G = (V, E)$ is called an m**-generalized fullerene**[1] if exactly two of its faces are m-gons and all other faces are pentagons and/or hexagons. ote that for $m = 5, 6$ an m-generalized fullerene graph is a classical fullerene graph. As for the classical fullerenes it is easy to show that the number of pentagons is fixed, while the number of hexagons is not determined. The smallest m-generalized fullerene has $4m$ vertices and no hexagonal faces. Such graphs are sometimes called m**-barrels**. They have two m-gons and $2m$ pentagons and they can be elongated by inserting $k \geq 0$ layers of m hexagons between two half-barrels. An **m-barrel fullerene** $F(m, k)$ is obtained from the corresponding barrel by inserting $k \geq 0$ layers (or rings) of m hexagons between two halves of the barrel. For $m = 5$ and $m = 6$ we obtain classical fullerene nanotubes. Most of the nanotube properties are also preserved by m-barrel fullerene. Note that $F(m, k)$ has $n = 2m(k+2)$ vertices. The m-barrels Fullerene are on of the most symetric fullerene and highly symmetric structure allows for obtaining good bounds and even exact results on the number of perfect matchings in them.

The problem of hamiltonicity of fullerene graphs had been open for a long time. There were several partial results, until this special case of Barnette's conjecture was settled by Kardoš, who provided a computer-assisted proof [**?**].

Theorem 0.1. *For all natural numbers $m \geq 3$ and k, $F(m, k)$ is Hamiltonian.*

The existence of Hamiltonian cycles has several consequences important for matchings-related properties of m-barrell fullerene.

Proposition 0.2. *$F(m, k)$ has at least three different perfect matchings. Moreover, each edge of $F(m, k)$ is contained in some perfect matching of $F(m, k)$.*

m-barrel Fullerenes are a special case of planar bridgeless graphs. Recall the Lovász-Plummer conjecture which claims that perfmat G is exponential in n for every cubic bridgeless graph. It is a generalization of the Erdös-Rényi conjecture for 3-regular bipartite graphs [5]. The Lovász-Plummer conjecture for planar graphs was proved by

Chudnosky and Seymour [3], and the complete conjecture was demonstrated by Esperet-Kardos-King-Kral-Norine [4].

Theorem 0.3. *The number of perfect matchings in $F(m,k)$ is bounded from above by*

$$\begin{cases} \left(\left(\frac{1+\sqrt{5}}{2}\right)^m + \left(\frac{1-\sqrt{5}}{2}\right)^m\right)\left(\left(\frac{1+\sqrt{5}}{2}\right)^{2m} + \left(\frac{1-\sqrt{5}}{2}\right)^{2m} + 2\right)^{\frac{k+1}{2}} & \text{if } m \text{ is odd;} \\ \left(\left(\frac{1+\sqrt{5}}{2}\right)^m + \left(\frac{1-\sqrt{5}}{2}\right)^m + 2\right)\left(\left(\frac{1+\sqrt{5}}{2}\right)^{2m} + \left(\frac{1-\sqrt{5}}{2}\right)^{2m} + 2\right)^{\frac{k+1}{2}} & \text{if } m \text{ is even.} \end{cases}$$

Proposition 0.4. $\Phi(F(3,k)) = 3^{k+2} + 1$.

Proposition 0.5.

$$\Phi(F(4,k)) = 2(2+\sqrt{2})^{k+1} + 2(2-\sqrt{2})^{k+1} + 2^{k+3} + 1.$$

Proposition 0.6.

$$\Phi(F(5,k)) = 5^{k+2} + 5\left[\left(\frac{5+\sqrt{5}}{2}\right)^k + \left(\frac{5-\sqrt{5}}{2}\right)^k\right] + 1.$$

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On the Submodular Function Minimization

Ardeshir Dolati
Shahed University, Iran

Submodularity is an important property of functions in a variety of fields such as discrete optimization, combinatorial optimization, artificial intelligence and probability. Some examples of submodular functions are cut capacity functions, matroid rank functions, and entropy functions. Minimizing submodular functions problem has recently attracted significant attention in the field of combinatorial optimization. This problem appears in many applicable areas such as image segmentation, natural language processing, speech analysis, machine learning, wireless and power networks. Therefore, faster ways to solve this problem is still an important topic for researchers. Here, we consider a condition under which we enable find a minimizer of a submodular function in less time complexity compared to existing algorithms.

This is a joint work with Saeed Hanifehnezhad.

Induced Cycles in Circulant Graphs

Mohammad Farrokhi Derakhshandeh Ghouchan
Institute for Advanced Studies in Basic Sciences (IASBS), Iran

Let $\mathbb{F}(n)$ denote the maximum non-negative integer m for which all circulant graphs on C_m are C_n-free. We show that

$$\mathfrak{F}(n) = 12k + \lceil \frac{3i}{2} \rceil - \delta_{1,\lfloor \frac{i}{2} \rfloor} - 1$$

for any positive integer $n > 2$, where k and i are defined as $n = 8k + i$ with $i \in \{0, \ldots, 7\}$, and δ denotes the Kronecker delta.

On Nonnegative Signed Domination Parameters in Graphs

Arezoo N. Ghameshlou
University of Tehran, Iran

Let $1 \leq k \leq n$ be a positive integer. A *nonnegative signed k-subdominating function* is a function $f : V(G) \to \{-1, 1\}$ satisfying $\sum_{u \in N_G[v]} f(u) \geq 0$ for at least k vertices v of G. The value $\min \sum_{v \in V(G)} f(v)$, taking over all nonnegative signed k-subdominating functions f of G, is called the *nonnegative signed k-subdomination number* of G and denoted by $\gamma_{ks}^{NN}(G)$. If $k = |V(G)|$, then $\gamma_{ks}^{NN}(G) = \gamma_s^{NN}(G)$ is the *nonnegative signed domination number*, introduced by Huang, et.al. In this paper, we investigate several sharp lower bounds of $\gamma_s^{NN}(G)$, which extend some presented lower bounds on $\gamma_s^{NN}(G)$.

We also initiate the study of the nonnegative signed k-subdomination number in graphs and establish some sharp lower bounds for $\gamma_{ks}^{NN}(G)$ in terms of the order and the degree sequence of a graph G.

An Eigendecomposition Problem

Narges Ghareghani
University of Tehran, Iran

Considering integers $0 \leq k \leq \ell$ and a sequence $B = (b_1, b_2, \ldots, b_\ell)$ of integers greater than 1, a $(0,1)$ matrix A is introduced based on an incidence structure related to these parameters. This matrix has origins in computational biology as well as combinatorics. We use combinatorial tools to study eigendecompositions of $A^\top A$ and $AA^\top$. Furthermore, we obtain concrete bases for the null space and the row space of A.

This is talk is based on a joint work with Morteza Mohammad-noori and Mahmoud Ghandi.

LDPC Codes Based on Affine Permutation Matrices

Mohammad Gholami
Shahrekord University, Iran

Low-density parity-check codes from *Affine permutation matrices*, called APM-LDPC codes, are a class of LDPC codes whose parity-check matrices consist of zero matrices or affine permutation matrices of the same orders. APM-LDPC codes are not quasi-cyclic (QC) in general. In this paper, necessary and sufficient conditions are provided for an APM-LDPC code to have cycles of length $2l$, $l \geq 2$, and a deterministic algorithm is given to generate APM-LDPC codes with a given girth. Unlike Type-I conventional QC-LDPC codes, the constructed (J, L) APM-LDPC codes with the $J \times L$ all-one base matrix can achieve minimum distance greater than $(J+1)!$ and girth larger than 12. Moreover, the lengths of the constructed APM-LDPC codes, in some cases, are smaller than the best known lengths reported for QC-LDPC codes with the same base matrices. Another significant advantage of the constructed APM-LDPC codes is that they have remarkably fewer girth multiplicities compared to QC-LDPC codes with the same base matrices and the same lengths. Simulation results show that the binary and nonbinary constructed APM-LDPC codes with lower girth outperform QC-LDPC codes with larger girth.

On Bipartite Distance-Regular Cayley Graphs with Diameter 3

Mojtaba Jazaeri
Shahid Chamran University of Ahvaz, Iran

The problem " which distance-regular graphs are Cayley graphs" is a problem in area of algebraic graph theory which has been well-studied for some special cases. Here we deal with this problem on bipartite distance-regular graphs with diameter 3. A bipartite distance-regular graph is the same as the incidence graph of a symmetric 2-design. we first obtain the intersection array of a bipartite distance-regular Cayley graph with diameter 3 and then, up to isomorphism, we speak about the classification of bipartite distance-regular Cayley graphs with small valencies.

Upper k-Tuple Total Dominating Sets in Graphs

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Let $G = (V, E)$ be a simple graph. For any integer $k \geq 1$, a subset of V is called a k-tuple total dominating set of G if every vertex in V has at least k neighbors in the set. The minimum cardinality of a minimal k-tuple total dominating set of G is called the k-tuple total domination number of G.

In this talk, we introduce the concept of upper k-tuple total domination number of G as the maximum cardinality of a minimal k-tuple total dominating set of G, and study the problem of finding a minimal k-tuple total dominating set of maximum cardinality on several classes of graphs, as well as finding general bounds and characterizations. Also, we find some results on the upper k-tuple total domination number of the Cartesian and cross product graphs.

Application of Cyclotomic Number Fields in Information Security

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We consider the application of cyclotomic number fields, in information security. We present an overview of recent advances in the area of information security using algebraic number fields. This overview indicates the importance of modular lattices in information security and recently proposed methods for obtaining modular lattices using algebraic number fields. Then, we use a special family of number fields, that is the cyclotomic number fields, to construct p-modular lattices, for a prime number p of the form $4k + 1$ and k a positive integer. In this family of modular lattices, the case $p = 5$ is applicable in information security. The construction of unimodular lattices using cyclotomic number fields of prime orders and lattice Construction A have been addressed in the literature. Using the generalized version of Construction A over complex multiplication fields, we prove that there is no modular lattices built using Construction A over cyclotomic fields of prime power order p^n, with $n > 1$.

This is a joint work with Mohammad-Reza Sadeghi.

Existence of Some Signed Magic Arrays

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We consider the notion of a signed magic array, which is an $m \times n$ rectangular array with the same number of filled cells s in each row and the same number of filled cells t in each column, filled with a certain set of numbers that is symmetric about the number zero, such that every row and column has a zero sum. We attempt to make progress toward a

characterization of for which (m, n, s, t) there exists such an array. This characterization is complete in the case where $n = s$ and in the case where $n = m$; we also characterize three-fourths of the cases where $n = 2m$.

Figure 1 displays a 5×5 diagonal signed magic square with three filled cells in each row and each column and a 3×5 signed magic array with no empty cells.

2	3			−5
−7	1	6		
	−4	0	4	
		−6	−1	7
5			−3	−2

1	−1	2	−2
5	4	−5	−4
−6	−3	3	6

Figure 1: A diagonal $SMS(5; 3)$ and an $SMA(3, 4)$.

Joint work with Christian Schulz, Rose Hulman Institute of Technology, IN, USA and Nathan Wagner, Bucknell University, PA, USA

Monochromatic Hamiltonian Berge-Cycles in 4-Uniform Colored Hypergraphs

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For given $r \geq t \geq 2$, an *r-uniform t-tight Berge-cycle of length n*, denoted by $C_n^{(r,t)}$, is an r-uniform hypergraph with the core sequence $v_1, v_2, \ldots, v_n$ as the vertices, and distinct edges $e_1, e_2, \ldots, e_n$ such that e_i contains $v_i, v_{i+1}, \ldots, v_{i+t-1}$, where addition is done modulo n. A t-tight Berge-cycle of length n in a hypergraph with n vertices is called a *Hamiltonian t-tight Berge-cycle*. Recently, the Ramsey numbers of various variations of cycles in uniform hypergraphs have been studied. Considering this problem for Berge-cycles Gyárfás et al. in 2008 conjectured that for any fixed r and sufficiently large n, there is a monochromatic Hamiltonian Berge-cycle in every $(r-1)$-coloring of the edges of K_n^r, the complete r-uniform hypergraph on n vertices. In this paper, we show that the statement of this conjecture is true with $r-2$ colors (instead of $r-1$ colors). Also, we give a proof for this conjecture when $r = 4$ (the first open case).

This is a joint work with G. R. Omidi.

On Rank of Signed Graphs

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A *signed graph* G^σ consists of an unsigned graph G and a sign σ, which is a mapping, $\sigma : E(G) \to \{-1, 1\}$. Let the adjacency matrix of a graph G be $A(G) = [a_{ij}]$. Then, the signed adjacency matrix of the signed graph G^σ is denoted by $A(G^\sigma) = [a_{ij}^\sigma]$, where

$a_{ij}^{\sigma} = \sigma(v_iv_j)$ if v_i and v_j are adjacent vertices, and $a_{ij}^{\sigma} = 0$, otherwise. The rank of a signed graph is defined to be the rank of its signed adjacency matrix.
In this paper, we study signed graphs which have full rank, and especially focus on Seidel matrices of graphs. We show that for any arbitrary simple graph G, there is a sign σ so that G^{σ} has full rank if and only if G has a spanning subgraph which is a disjoint union of some copies of K_2 and some cycles. We also characterize all complete graphs that can be signed not to have full rank. More specifically, we show that if $n \not\equiv 1 \pmod 4$, then the Seidel matrix of any graph of order n has full rank, and if $n \equiv 1 \pmod 4$, then there exists a graph of order n such that its Seidel matrix does not have full rank.

This is a joint work with S. Akbari, A. Ghafari, and K. Kazemian.

High-Rate Girth-6 LDPC Codes with Flexible Column-Weights

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In this paper, an approach is proposed to increase the column-weight of the parity-check matrix of a 4-cycle free LDPC code such that the constructed LDPC code has the girth at least 6. For this purpose, Let $H = (h_{i,j})_{v\times b}$ be the parity-check matrix of an LDPC code and $\mathcal{B} = \{B_1, B_2, \ldots, B_v\}$, where for each $1 \le i \le v$, $B_i = \{1 \le j \le b,\ h_{ij} = 1\}$ is the column-indices of nonzero elements in row i. Let $G_r(H)$ be a graph with vertices $B_1, \ldots, B_v$. Two vertices B_i and B_j are adjacent if and only if $B_i \cap B_j \neq \emptyset$. Let $C = \{c_1, c_2, \ldots, c_v\}$ be a vertex coloring of $G_r(H)$, such that c_i, $1 \le i \le v$, is the color of the vertex B_i. Set $H_h(C) = (H|K)$ be the concatenated of two matrices H and K horizontally in which $K = (k_{ij})$ is a $v \times |C|$ binary array with $k_{ij} = 1$ if and only if $c_i = j$. Using the same approach for H^T (the transpose of H), we can extend H vertically as $H_v(C) = (H_h^T)^T = (\frac{H}{k})$, where C is a vertex coloring for $G_c(H)$, the graph induced by the columns of H, and K is a $|C| \times b$ array with $k_{ij} = 1$ if and only if $c_j = i$. Now, based on Lemma 3.2, $H_h(C)$ ($H_v(C)$) can be considered as the parity-check matrix of a 4-cycle free LDPC code with rate at least $1 - \frac{v}{b+|C|}(1 - \frac{v+|C|}{b})$, if H is 4-cycle free. Based on this method, some high-rate LDPC codes with girth 6 and Flexible column(row)-weights can be constructed from the recently proposed LDPC codes with girth 6. Simulation results show that the constructed codes have better bit-error performance, when the row-weight enlarges and have large minimum-distance when the column-weight enlarges.

This is a joint work with Mohammad Gholami.

Some Results on the Third Largest Eigenvalue of Graphs

Mohammad Reza Oboudi
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Let G be a graph with eigenvalues $\lambda_1(G) \ge \cdots \ge \lambda_n(G)$. We show that if the multiplicity of -1 as an eigenvalue of G is at most $n - 13$, then $\lambda_3(G) \ge 0$. We prove that $\lambda_3(G) \in \{-\sqrt{2}, -1, \frac{1-\sqrt{5}}{2}\}$ or $-0.59 < \lambda_3(G) < -0.5$ or $\lambda_3(G) > -0.496$. We find that

$\lambda_3(G) = -\sqrt{2}$ if and only if $G \cong P_3$ and $\lambda_3(G) = \frac{1-\sqrt{5}}{2}$ if and only if $G \cong P_4$, where P_n is the path on n vertices. In addition we characterize the graphs whose third largest eigenvalue equals -1. We find all graphs G with $-0.59 < \lambda_3(G) < -0.5$. Finally we investigate the limit points of the set $\{\lambda_3(G) :$ G is a graph such that $\lambda_3(G) < 0\}$ and show that 0 and -0.5 are two limit points of this set.

Ore-type Results for the Stripes Ramsey Numbers

Ghaffar Raeisi
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For given graphs $G, G_1, G_2, \ldots, G_l$, we write $G \to (G_1, G_2, \ldots, G_l)$ if the edges of G are partitioned into l disjoint color classes giving l graphs $H_1, H_2, \ldots, H_l$, then at least one H_i has a subgraph isomorphic to G_i. The Ramsey number $R(G_1, G_2, \ldots, G_l)$ is defined as the the smallest positive integer n such that $K_n \to (G_1, G_2, \ldots, G_l)$. Also by $ex(n, G_1, G_2, \ldots, G_l)$ we mean the maximum possible number of edges in an n vertex graph G such that $G \nrightarrow (G_1, G_2, \ldots, G_l)$. In this talk, we extend the result of Cockayne and Lorimer on the Ramsey number of stripes allowing host graphs with the corresponding Ore-type condition: If $t, n_1, n_2, \ldots n_l$, $n_1 = \max\{n_1, n_2, \ldots n_l\}$, are positive integers and G is a graph on at least $\max\{t, n_1\} + \sum_{i=1}^{l}(n_i - 1) + 1$ vertices such that for each pair of non-adjacent vertices, the sum of the number of their non-neighbors is at most $2t - 1$, then $G \to (n_1K_2, n_2K_2, \ldots, n_lK_2)$. Consequently, we obtain that

$$R(S_t, n_1K_2, n_2K_2, \ldots, n_lK_2) = \max\{t, n_1\} + \sum_{i=1}^{l}(n_i - 1) + 1.$$

In addition, for positive integers $n_1, n_2, \ldots n_l$, $n_1 = \max\{n_1, n_2, \ldots n_l\}$, the value of the $ex(n, n_1K_2, n_2K_2, \ldots, n_lK_2)$ is computed exactly and extremal graphs are classified. As a result, we give a new proof for the graph case of a conjecture of Erdős dating back to 1965, known as the Erdős' matching conjecture.

This is a joint work with G. R. Omidi.

Practical Computation of Autotopism Groups of Partial Latin Rectangles

Rebecca J. Stones
Nankai University, China

We experimentally compare methods for practically computing the autotopism groups of partial Latin rectangles (two backtracking methods and four graph theoretic methods) along with entry invariants. The aim is to identify the design goals for efficient software for computing these autotopism groups.

This is joint work with Raul M. Falcon (U. Seville, Spain) and Daniel Kotlar.

On Minimal Generating Sets for Symmetric Groups

Reza Taleb
Shahid Beheshti University, Iran

By a famous result, the subgroup generated by the n-cycle $\sigma = (1, 2, \cdots, n)$ and the transposition (a, b) is the full symmetric group S_n if and only if $gcd(n, b - a) = 1$. In this talk, using the connectivity of certain graphs, similar necessary and sufficient conditions for the subgroups of S_n are provided in the following two cases: first the subgroup generated by the n-cycle σ and a 3-cycle (a, b, c), and second the subgroup generated by the n-cycle σ and an involution $(a, b)(c, d)$. In the first case we also determine the structure of the subgroup generated by $(1, 2, \cdots, n)$ and a 3-cycle (a, b, c) in general. Finally an application to unsolvability of a certain infinite family of polynomials by radicals is given.

This is a joint work with Moharram N. Iradmusa.

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