INSTITUTE FOR RESEARCH IN FUNDAMENTAL SCIENCES

IPMCCC 2021

The 4th IPM Biennial Conference on Combinatorics and Computing

Institute for Research in Fundamental Sciences, IPM, Tehran, Iran

May 17-20, 2021

To participate, you NEED to register by May 14th at

http://math.ipm.ac.ir/IPMCCC2021

INSTITUTE FOR RESEARCH IN FUNDAMENTAL SCIENCES

IPM

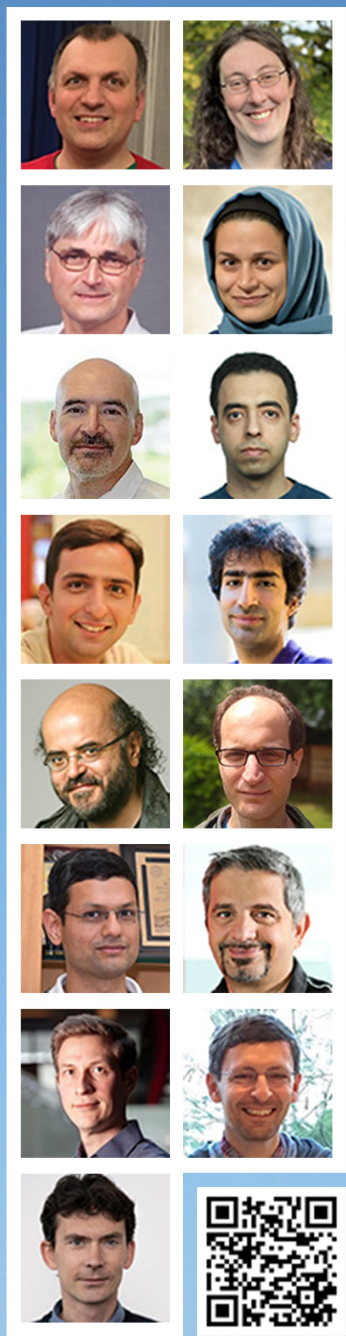
پژوهشگاه‌دانش‌های‌بنیادی

The 4th IPM Biennial Conference on Combinatorics and Computing

IPMCCC 2021

May 17-20, 2021

Online Event



Invited Speakers

Amin Coja-Oghlan, Goethe University, Germany

David Conlon, California Institute of Technology, USA

Zoltán Füredi, Rényi Institute, Hungary, U of Illinois, USA

Sepideh Mahabadi, TTIC, USA

Gary McGuire, University College Dublin, Ireland

Ali Mohammadi, IPM, Iran

Amir Najafi, IPM, Iran

Shayan Oveis Gharan, University of Washington, USA

Christos Papadimitriou, Columbia University, USA

Giorgis Petridis, University of Georgia, USA

Nitin Saxena, IIT Kanpur, India

Amin Shokrollahi, EPFL and Kandou Bus, Switzerland

Ola Svensson, EPFL, Switzerland

Luca Trevisan, Bocconi University, Italy

Thomas Vidick, California Institute of Technology, USA

Important Dates

Submission Deadline: April 10, 2021

Registration Deadline: May 14, 2021

math.ipm.ac.ir/IPMCCC2021

Welcome to IPMCCC 2021!

We are very happy that despite the COVID-19 pandemic, we have a great list of speakers for the conference. I thank all of the speakers. I also thank all of the members of the scientific committee and the organizers of the conference, who made the conference possible. I hope that you all enjoy the talks, and this conference helps you find great problems for research to work on.

Omid Etesami,
On behalf of the Scientific and Organizing Committees of IPMCCC 2021.

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, NanoScience, Particles and Accelerator, and Physics. It enjoys an expanding base of infrastructures and facilities (electronic networking, computers, laboratories, a wellequipped and uptodate 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, Nonresident Researchers, and Student Researchers in fulltime, parttime, and nonresident modes.

About IPMCCC 2021

The fourth IPM biennial conference on combinatorics and computing (IPMCCC 2021) will be held on May 17-20, 2021. Because of the pandemic situation of Covid 19, the conference will be held virtually. The conference is organized by the Combinatorics and Computing Group of IPM. The purpose of IPMCCC 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.

Scientific Committee

- **Omran Ahmadi** (IPM, Iran)
- **Salman Beigi** (IPM, Iran)
- **Omid Etesami (Chair)** (IPM, Iran)
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- **Meysam Miralaei** (IPM, Iran)
- **Ali Mohammadi** (IPM, Iran)
- **Saeid Sadri** (IPM, Iran)

Invited Speakers

- **Amin Coja-Oghlan** (Goethe University, Germany)
- **David Conlon** (California Institute of Technology, USA)
- **Zoltán Füredi** (Rényi Institute for Mathematics, Hungary)
- **Sepideh Mahabadi** (Toyota Technological Institute at Chicago (TTIC), USA)
- **Gary McGuire** (University College Dublin, Ireland)
- **Ali Mohammadi** (IPM, Iran)
- **Amir Najafi** (IPM, Iran)
- **Shayan Oveis Gharan** (University of Washington, USA)
- **Christos Papadimitriou** (Columbia University, USA)
- **Giorgis Petridis** (University of Georgia, USA)
- **Nitin Saxena** (Indian Institute of Technology, Kanpur, India)
- **Amin Shokrollahi** (EPFL and Kandou Bus, Switzerland)
- **Ola Svensson** (EPFL, Switzerland)
- **Luca Trevisan** (Bocconi University, Italy)
- **Thomas Vidick** (California Institute of Technology, USA)

Conference Program:

Monday May 17			
Tehran Time	**Speaker**	**Title of the talk**	**Speaker's Local Time**
9:45-10:00 AM	***Welcoming Remarks***		
10:00-11:00 AM	**Amin Shokrollahi**	Chord Signaling	7:30-8:30 AM, Swiss time
11:30-12:30 AM	**Thomas Vidick**	MIP*=RE: Verifying the Halting Problem with Quantum Provers	9:00-10:00 AM, French time
12:30-2:00 PM	***Lunch (on your own)***		
2:00-3:00 PM	**Nitin Saxena**	A Largish Sum-of-Squares Implies Circuit Hardness and Derandomization	3:00-4:00 PM, Indian time
3:30-4:30 PM	**Zoltan Furedi**	Monochromatic Components in Almost Complete Graphs	1:00-2:00 PM, Hungarian time
5:00-5:30 PM	**Masoumeh Koohestani**	Spectral Classes of Distance-Regular Graphs	5:00-5:30 PM, Tehran time
5:30-6:00 PM	**Somayeh Khalashi Ghezelahmad**	Lower and Upper Bounds on Trace Norm of Digraphs	5:30-6:00 PM, Tehran time

Tuesday May 18			
Tehran Time	**Speaker**	**Title of the talk**	**Speaker's Local Time**
10:00-11:00 AM	**Ali Mohammadi**	New Sum-Product Estimates in Finite Fields and Applications	10:00-11:00 AM, Tehran time
11:30-12:00 AM	**Ozra Naserian**	An Extension Theorem for t-Regular Self-Complementary k-Hypergraphs	11:30-12:00 AM, Tehran time
12:00-12:30 PM	**Babak Ghanbari**	Fractional Forcing Number of Graphs	12:00-12:30 PM, Tehran time
12:30-2:00 PM	***Lunch (on your own)***		
2:00-3:00 PM	**Luca Trevisan**	Graph and Hypergraph Sparsification	11:30-12:30 AM, Italian time
3:30-4:30 PM	**David Conlon**	Subset Sums, Completeness and Colourings	12:00-1:00 PM, Irish time
5:00-6:00 PM	**Sepideh Mahabadi**	Diversity and Fairness in Data Summarization Algorithms	7:30-8:30 AM, US Central time

Wednesday May 19			
Tehran Time	**Speaker**	**Title of the talk**	**Speaker's Local Time**
8:00-9:00 AM	**Shayan Oveis Gharan**	Strongly Rayleigh Distributions and a (Slightly) Improved Approximation Algorithm for Metric TSP	8:30-9:30 PM, US Pacific time (Tuesday in US)
9:30-10:00 AM	**Amir Saki**	Takasaki Quandles: A Lattice Theoretical Point of View and an Application in Machine Learning	9:30-10:00 AM, Tehran time
10:00-10:30 AM	**Meysam Miralaei**	On the Size-Ramsey Number of Grid Graphs	10:00-10:30 AM, Tehran time
11:00-12:00 AM	**Ola Svensson**	Learning-Augmented Online Algorithms and the Primal-Dual Method	8:30-9:30 AM, Swiss time
12:00-2:00 PM	***Lunch (on your own)***		
2:00-3:00 PM	**Gary McGuire**	Linear Fractional Transformations and Irreducible Polynomials over Finite Fields	10:30-11:30 AM, Irish time
3:00-5:00 PM		***Break***	
5:00-6:00 PM	**Giorgis Petridis**	Small Progress Toward the Paley Graph Conjecture	8:30-9:30 AM, US Eastern time

Thursday May 20			
Tehran Time	**Speaker**	**Title of the talk**	**Speaker's Local Time**
2:00-3:00 PM	**Amin Coja-Oghlan**	Group Testing	11:30-12:30 AM, German time
3:30-4:30 PM	**Amir Najafi**	Robustness to Adversarial Perturbations in Learning from Incomplete Data	3:30-4:30 PM, Tehran time
5:00-6:00 PM	**Christos Papadimitriou**	Computation, Brain, and Language	8:30-9:30 AM, US Eastern time

Abstracts of the Talks
(In Alphabetical Order)

Invited Speakers

Group Testing

Thursday
2:00-3:00 PM

Amin Coja-Oghlan
Goethe University, Germany

In the group testing problem the goal is to identify a small number of infected individuals within a large population. To this end we avail ourselves of a test procedure capable of testing several individuals at once. The test will come back positive iff any one of the tested individuals is actually infected. How can we deploy the tests so as to identify the infected individuals with as small a total number of tests as possible? In this talk I will present some recent mathematical results as well as the results of an experimental study for moderate population sizes.

Subset Sums, Completeness and Colourings

Tuesday
3:30-4:30 PM

David Conlon
California Institute of Technology, USA

We develop novel techniques which allow us to prove a diverse range of results relating to subset sums and complete sequences of positive integers, including solutions to several longstanding open problems. These include: solutions to the three problems of Burr and Erdős on Ramsey complete sequences, for which Erdős later offered a combined total of \$350; analogous results for the new notion of density complete sequences; the solution to a conjecture of Alon and Erdős on the minimum number of colours needed to colour the positive integers less than n so that n cannot be written as a monochromatic sum; the exact determination of an extremal function introduced by Erdős and Graham on sets of integers avoiding a given subset sum; and, answering a question reiterated by several authors, a homogeneous strengthening of a seminal result of Szemerédi and Vu on long arithmetic progressions in subset sums.
This talk is based on a joint work with Jacob Fox and Huy Tuan Pham.

Monochromatic Components in Almost Complete Graphs

Monday
3:30-4:30 PM

Zoltán Füredi

Rényi Institute for Mathematics, Hungary

The aim of this talk is to show that using continuous mathematics can help in discrete mathematics. We illustrate this with two examples:
Gyarfas proved that every coloring of the edges of K_n with $t + 1$ colors contains a monochromatic connected component of size at least n/t. Later, Gyarfas and Sarkozy found an amazing stability of this result, namely that for some $\gamma = \gamma(t) > 0$ the following strengthening holds for almost complete graphs: if G is an n-vertex graph with minimum degree at least $(1 - \gamma)n$, then every $(t + 1)$-edge coloring of G contains a monochromatic component of size at least n/t. We show $\gamma = 1/(6t^3)$ suffices, improving the results of DeBiasio, Krueger, and Sarkozy as well.
We also point out connections to $(t + 1)$-partite hypergraphs, fractional matchings, and regular intersecting families.
The new results are joint with Ruth Luo (UCSD).

Diversity and Fairness in Data Summarization Algorithms

Tuesday
5:00-6:00 PM

Sepideh Mahabadi

Toyota Technological Institute at Chicago (TTIC), USA

Searching and summarization are two of the most fundamental tasks in massive data analysis. In this talk, I will focus on these two tasks from the perspective of diversity and fairness. Search is often formalized as the (approximate) nearest neighbor problem. Despite an extensive research on this topic, its basic formulation is insufficient for many applications. In this talk, I will describe such applications and our approaches to address them. For example, we show how to incorporate diversity or fairness in the results of a search query.

A prominent approach to summarize the data is to compute a small core-set: a subset of the data that is sufficient for approximating the solution of a given task. We introduce the notion of "composable core-sets" as core-sets with the composability property: the union of multiple core-sets should form a good summary for the union of the original data sets. This composability property enables efficient solutions to a wide variety of massive data processing applications, including distributed computation (e.g. Map-Reduce model), streaming algorithms, and similarity search. We show how to produce such efficient summaries of the data while preserving the diversity in the data set. I will describe several metrics for capturing the notion of diversity, and present efficient algorithms for construction of composable core-sets with respect to those metrics.

Linear Fractional Transformations and Irreducible Polynomials over Finite Fields

Wednesday
2:00-3:00 PM

Gary McGuire
University College Dublin, Ireland

We will discuss polynomials over a finite field where linear fractional transformations permute the roots. For subgroups G of $PGL(2, q)$ we will demonstrate some connections between factorizations of certain polynomials into irreducible polynomials over F^q, and the field of G-invariant rational functions. Some unusual patterns in the factorizations are explained by this connection.

New Sum-Product Estimates in Finite Fields and Applications

Tuesday
10:00-11:00 AM

Ali Mohammadi
Institute for Research in Fundamental Sciences (IPM), Iran

The finite field variant of the Erdős-Szemerédi sum-product problem seeks to establish, in a quantitative manner, that subsets of finite fields do not exhibit strong additive and multiplicative structure simultaneously unless they largely correlate with a dilate of a subfield. In this talk, I will briefly discuss recent progress on this problem and proceed to explore various applications. In particular, I will outline an argument leading to a refinement and quantitative improvement of a result of Chang on equidistribution of orbits of quadratic polynomials.
This talk is based on joint work with Sophie Stevens.

Robustness to Adversarial Perturbations in Learning from Incomplete Data

Thursday
3:30-4:30 PM

Amir Najafi

Institute for Research in Fundamental Sciences (IPM), Iran

What is the role of unlabeled data in a statistical learning scenario, when the presumed underlying data distribution is adversarially perturbed? In this talk, I explain how we answer to this question by unifying two major learning frameworks: Semi-Supervised Learning (SSL) and Distributionally Robust Optimization (DRO). We develop a generalization theory for our framework based on a number of novel complexity measures, such as an adversarial extension of Rademacher complexity and its semi-supervised analogue. Moreover, our analysis is able to quantify the role of unlabeled data in the generalization process under a more general condition compared to existing works in SSL. We also present a hybrid of DRO and EM algorithms that has a guaranteed convergence rate. When implemented with deep neural networks, our method shows a comparable performance to those of the state-of-the-art on a number of real-world benchmark datasets.

Strongly Rayleigh Distributions and a (Slightly) Improved Approximation Algorithm for Metric TSP

Wednesday
8:00-9:00 AM

Shayan Oveis Gharan

University of Washington, USA

In an instance of the (metric) traveling salesperson problem (TSP), we are given a list of n cities and their pairwise symmetric distances satisfying the triangle inequality, and we want to find the shortest tour that visits all cities exactly once and returns back to the starting point. I will talk about an algorithm that provably returns a tour whose cost is at most 50-ϵ percent more than the optimum where $\epsilon > 0$ is a small constant independent of n. This slightly improves classical algorithms of Christofides and Serdyukov from the 1970s.

The proof exploits a deep connection to the rapidly evolving area of geometry of polynomials. In this area, we encode discrete phenomena, in our case uniform spanning tree distributions, in coefficients of complex multivariate polynomials, and we understand them via the interplay of the coefficients, zeros, and function values of these polynomials. Over the last fifteen years, this perspective has led to several breakthroughs in computer science and Mathematics such as simpler proofs of the van-der-Waerden conjecture, and resolutions of the Kadison-Singer and the Mihail-Vazirani conjectures. I will discuss how properties of strongly Rayleigh distributions,

a family of probability distributions whose generating polynomial is real stable, can be used to design and analyze algorithms for TSP.
This talk is based on a joint work with Anna Karlin and Nathan Klein.

Computation, Brain, and Language

Thursday
5:00-6:00 PM

Christos Papadimitriou
Columbia University, USA

How does the brain beget the mind? How do molecules, cells and synapses create reasoning, intelligence, language? Despite dazzling progress in neuroscience, we do not seem to be making progress in the overarching question. I will introduce the Assembly Calculus, a formal computational system aimed to bridge this gap and based on assemblies of neurons (large stable sets of neurons encoding memories, ideas, and words), and will describe its recent application to language.

Small Progress Toward the Paley Graph Conjecture

Wednesday
5:00-6:00 PM

Giorgis Petridis
University of Georgia, USA

Given a prime p that is congruent to 1 modulo 4, the Paley graph conjecture asserts that the size of a set A of residues with the property that $A-A$ consists entirely of quadratic residues is smaller than any power of p. We outline small progress toward the conjecture.

A Largish Sum-of-Squares Implies Circuit Hardness and Derandomization

Monday
2:00-3:00 PM

Nitin Saxena
Indian Institute of Technology, Kanpur, India

For a univariate polynomial f, a sum-of-squares representation (SOS) has the form $f = \sum_{i\in[s]} c_i f_i^2$, where c_i's are field elements and the f_i's are polynomials. The size of the representation is the number of monomials that appear across the f_i's. Its minimum is the support-sum $S(f)$ of f. For a polynomial f of degree d of full support, a lower bound for the support-sum is $S(f) \geq \sqrt{d}$. We show that the existence of an explicit polynomial f with support-sum just slightly larger than the lower bound, that is, $S(f) \geq d^{0.5+\varepsilon(d)}$, for a sub-constant function $\varepsilon(d) > \omega(\sqrt{\log\log d/\log d})$, implies that $VP \neq VNP$. The latter is *the* major open problem in algebraic complexity.
We also consider the sum-of-cubes representation (SOC) of polynomials. In a similar way, we show that an explicit hard polynomial even implies that blackbox-PIT is in P.
This talk is based on a joint work with Pranjal Dutta and Thomas Thierauf; published in ITCS 2021.

Chord Signaling

Monday
10:00-11:00 AM

Amin Shokrollahi
EPFL and Kandou Bus, Switzerland

Communication of data on electrical wires between chips is fast gaining prominence in the electronics industry. Because most of the components of the transmitter and the receiver of such links are analog, rather than digital, they dont benefit as much from Moores law. On the other hand, the need to transmit data ever faster calls for higher rates of transmission over existing electrical wires. Since in this type of communication noise is highly frequency dependent, higher transmission rates lead to much higher noise, and therefore a much higher growth of power consumption than linear. The industry has long recognised this problems as the Interconnect bottleneck. Fundamental solutions to this important problem have remained elusive, however.
A look at the capacity of these channels reveals that today we are only transmitting at anywhere between 1% to 4% of the capacity. Therefore, at least on the surface, there is a lot to be gained by applying methods from communication theory to this problem. However, unlike many other systems such as wireless, DSL, satellite, or

optical communication, the constraints on the chip-to-chip communication system are very different: transmission rates are typically 1000 times those encountered in wireless communication. On the other hand, the energy consumed for the transmission and recovery of each bit is about 1000 times less than what is customary in wireless. Also, latency requirements are extremely stringent, allowing only latencies up to very few nanoseconds. Therefore, it is not possible to use fancy processing methods.
In this talk I will introduce a new modulation scheme for chip-to-chip communication which we call chordal codes. These codes are somewhat reminiscent of spatial MIMO systems, and provide a first step towards a better utilization of the available communication bandwidth between chips. Current implementations of systems based on these codes show a large reduction of total power of the communication PHY and a large increase of the communication speed compared to other classical system.

Learning-Augmented Online Algorithms and the Primal-Dual Method

Wednesday
11:00-12:00 AM

Ola Svenson
EPFL, Switzerland

The design of learning-augmented online algorithms is a new and active research area. The goal is to understand how to best incorporate predictions of the future provided e.g. by machine learning algorithms that rarely come with guarantees on their accuracy.
In the absence of guarantees, the difficulty in the design of such learning-augmented algorithms is to find a good balance: on the one hand, following blindly the prediction might lead to a very bad solution if the prediction is misleading. On the other hand, if the algorithm does not trust the prediction at all, it will simply never benefit from an excellent prediction. An explosion of recent results solve this issue by designing smart algorithms that exploit the problem structure to achieve a good trade-off between these two cases.
In this talk, we will discuss this emerging line of work. In particular, we will show how to unify and generalize some of these results by extending the powerful primal-dual method for online algorithms to the learning augmented setting.

Graph and Hypergraph Sparsification

Tuesday
2:00-3:00 PM

Luca Trevisan
Bocconi University, Italy

A weighted graph H is a sparsifier of a graph G if H has much fewer edges than G and, in an appropriate technical sense, H "approximates" G. Sparsifiers are useful as compressed representations of graphs and to speed up certain graph algorithms. In a "cut sparsifier," the notion of approximation is that every cut is crossed by approximately the same number of edges in G as in H. In a "spectral sparsifier" a stronger, linear-algebraic, notion of approximation holds. Similar definitions can be given for hypergraph.
We discuss recent progress on constructions and lower bounds for graph and hypergraph sparsification, and we point out some challenging open problems.

$MIP^* = RE$: Verifying the Halting Problem with Quantum Provers

Monday
11:30-12:30 AM

Thomas Vidick
California Institute of Technology, USA

I will present joint work with Ji, Natarajan, Yuen and Wright (arXiv:2001.04383) in which we show that the complexity class MIP^* of languages that can be decided by a classical polynomial-time verifier interacting with untrusted quantum entangled provers is exactly the class RE of recursively enumerable languages. I will motivate this result by describing intertwined lines of work in quantum information and operator algebras that lead to it, present some of the key ideas that go in the proof, and discuss open questions raised by our work.

Contributed Talks

Fractional Forcing Number of Graphs

Tuesday
12:00-12:30 PM

Babak Ghanbari
Sharif University of Technology, Iran

The notion of forcing sets for perfect matchings was introduced by Harary, Klein, and Živković. The application of this problem in chemistry, as well as its interesting theoretical aspects, made this subject very active. In this work, we introduce the notion of the forcing function of fractional perfect matchings, which is continuous analogous to forcing sets defined over the perfect matching polytope of graphs. We show that our defined object is a continuous and concave function extension of the integral forcing set. Then, we use our results about this extension to conclude new bounds and results about the integral case of forcing sets for the family of edge and vertex-transitive graphs, and in particular, hypercube graphs.
This talk is based on a joint work with Javad B. Ebrahimi.

Lower and Upper Bounds on Trace Norm of Digraphs

Monday
5:30-6:00 PM

Somayeh Khalashi Ghezelahmad
Science and Research Branch, Islamic Azad University, Tehran, Iran

The energy of a graph G, $\mathcal{E}(G)$, is the sum of absolute values of the eigenvalues of its adjacency matrix. This concept was extended by Nikiforov to arbitrary complex matrices. Recall that the trace norm of a digraph D is defined as, $\mathcal{N}(D) = \sum_{i=1}^{n} \sigma_i$, where $\sigma_1 \geq \cdots \geq \sigma_n$ are the singular values of the adjacency matrix of D. In this paper we would like to present some lower and upper bounds for $\mathcal{N}(D)$. For any digraph D it is proved that $\mathcal{N}(D) \geq$ rank(D) and the equality holds if and only if D is a disjoint union of directed cycles and directed paths. It is shown that if D is a tournament of order $n \geq 5$, then $\mathcal{N}(D) > n$.

Spectral Classes of Distance-Regular Graphs

Monday
5:00-5:30 PM

Masoumeh Koohestani
K. N. Toosi Unversity of Technology, Tehran, Iran

Finding tools for comparison of the structures of large graphs is an important problem in graph theory and computer science with vast applications in other fields such as biology and pattern recognition, to name a few. Gu, Jost, Liu, and Stadler (2016) studied a (pseudo-)distance between graphs based on the spectrum of the normalized Laplacian. This quantity can be computed efficiently, and so it is suitable for comparing large graphs.

Let G be a graph on n vertices and $\mathcal{L}(G)$ be its normalizd Laplacian matrix. Let $\lambda_0 \leq \cdots \leq \lambda_{n-1}$ be the eigenvalues of $\mathcal{L}(G)$. We know that $\lambda_0 = 0$ and $\lambda_{n-1} \leq 2$. This yields the Radon probability measure

$$\mu(G) = \frac{1}{n} \sum_{i=0}^{n-1} \delta_{\lambda_i(G)},$$

on $[0, 2]$, where $\delta.$ denotes the Dirac measure. $0\mu(G)$ acts on continuous functions $f : [0, 2] \to \mathbb{R}$ as

$$\mu(G)(f) = \frac{1}{n} \sum_{i=0}^{n-1} f(\lambda_i(G)).$$

Let $(G_n)_{n\in\mathbb{N}}$ be a family of graphs where each G_n has n vertices. An important recent development in graph theory is concerned with the construction of suitable limits of such families for $n \to \infty$. Such limits should reflect the asymptotic behavior of isomorphism classes of subgraphs. The new notion of convergence proposed in Gu et al. is based on graph spectra, more precisely on the Radon measure defined above.

The family $\mu_n = \mu(G_n)$ of Radon measures on $[0, 2]$ converges weakly to the Radon measure ρ, denoted $\mu_n \to \rho$, if $\rho(f) = \lim_{n\to\infty} \mu_n(f)$ for all continuous functions $f : [0, 2] \to \mathbb{R}$. In such a case we say that the family (G_n) of graphs belongs to the spectral class ρ.

We study the convergence of families of strongly-regular graphs and distance-regular graphs with classical parameters. Such distance-regular graphs include Hamming and Johnson graphs and few more classes.
This talk is based on a joint work with Ebrahim Ghorbani.

On the Size-Ramsey Number of Grid Graphs

Wednesday
10:00-10:30 AM

Meysam Miralaei
School of Mathematics, Institute for Research in Fundamental Sciences (IPM)

For two graphs F and G, we say that G is *Ramsey for* F and write $G \longrightarrow F$, if every 2-coloring of the edges of G yields a monochromatic copy of F. Erdős, Faudree, Rousseau, and Schelp defined the *size-Ramsey number* $\hat{r}(F)$ of F to be the smallest integer m such that there exists a graph G with m edges that is Ramsey for F, i.e.,

$$\hat{r}(F) = \min\{e(G) \colon G \longrightarrow F\}.$$

Size-Ramsey numbers of graphs have been studied for almost 50 years with particular focus on the case of trees and bounded degree graphs (sparse graphs).

Addressing a question posed by Conlon and Nenadov we focus on 2-dimensional grids. The $s \times t$ *grid graph* $G_{s,t}$ is defined on the vertex set $[s] \times [t]$ with edges uv present, whenever u and v differ in exactly one coordinate by exactly one. We prove that the size-Ramsey number of the grid graph on $\sqrt{n} \times \sqrt{n}$ vertices is bounded from above by $n^{3/2+o(1)}$.
This talk is based on a joint work with Dennis Clemens, Damian Reding, Mathias Schacht and Anusch Taraz.

An Extension Theorem for t-Regular Self-Complementary k-Hypergraphs

Tuesday
11:30-12:00 AM

Ozra Naserian
Islamic Azad University, Zanjan, Iran

A k-hypergraph with vertex set V and edge set E is called t-regular if every t-element subset of V lies in the same number of elements of E. In this note, we give the necessary and sufficient conditions for the existence of some new families of 3-regular self-complementary k-hypergraphs for $k = 4, 5, 6, 7$.
This talk is based on a joint work with M. Emami and A.H. Shokouhi.

Takasaki Quandles: A Lattice Theoretical Point of View and an Application in Machine Learning

Wednesday
9:30-10:00 AM

Amir Saki

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A quandle is a set X together with a bijective self-distributive binary operation $\triangleright$ such that each $x \in X$ is an idempotent. Let A be an abelian group. Then, A is turned into a quandle by setting $x \triangleright y = 2x - y$ for any $x, y \in A$. This quandle is called the Takasaki quandle of A, and it is denoted by $T(A)$. In this talk, on one hand, the lattice of subquandles of a Takasaki quandle is investigated. Indeed, for a finite abelian group A, it is shown that $\mathcal{R}(A)$ is the coset lattice of A if and only if A is of odd order or its 2-Sylow subgroup is cyclic. Further, the homotopy type of $\mathcal{R}(T(A))$ is completely determined. Furthermore, it is shown that $\mathcal{R}(T(A)) \cong \mathcal{R}(T(B))$ implies that $A \cong B$ as groups, for any finite abelian groups A and B. On the other hand, an application of involutory quandles as a generalization of Takasaki quandles is introduced in machine learning. Indeed, an involutory quandle is a quandle X with the additional property $y \triangleright (y \triangleright x) = x$ for any $x, y \in X$. To see the motivation, note that the map $f_x : \mathbb{R}^2 \to \mathbb{R}^2$ sending any $y \in \mathbb{R}^2$ to $2x - y$ is a point reflection. So, the group generated by the aforementioned maps contains all translations in $\mathbb{R}^2$. Translations are important in image processing, since a photo and its translations should be considered the same.

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