IMBM istanbul matematiksel bilimler merkezi
istanbul center for mathematical sciences

Discrete Mathematics Days

Saturday, October 27, 2018

09:00 - 09:30: Registration

09:30 - 09:45: Opening Talks

09:45 - 10:30: Müge Taşkın Aydın (Boğaziçi University, Istanbul)
Combinatorics of Young and Tower Diagrams

10:30 - 11:15: Zafeiriakis Zaferoupoulos (Gebze Technical University, Kocaeli)
Using Polyhedral Geometry in Combinatorics

11:15 - 12:00: Mohan Ravichandran (Mimar Sinan University, Istanbul)
Counting Independent Sets in Graphs and Hypergraphs

12:00 - 13:30: Lunch

13:30 - 14:30 (*Special Lecture*): Yusuf Civan (Süleyman Demirel University, Isparta)
Castelnuovo-Mumford Regularity of Graphs

14:30 - 15:15: Hamza Yeşilyurt (Bilkent University, Ankara)
Shifted and Shiftless Partition Identities

15:15 - 15:30: Coffee Break

15:30 - 16:15: Kağan Kurşungöz (Sabancı University, Istanbul)
Andrews-Gordon type series for Capparelli's Identities, Kanade-Russell Conjectures, and Schur's Identity

16:15 - 17:00: Jehanne Dousse (Univesitat Zürich, Switzerland)
A Combinatorial Approach to Partition Identities from Representation Theory

17:00 - 17:15: Coffee Break

17:15 - 18:00: Ali Kemal Sinop (TOBB University of Economics and Technology, Ankara)
Semidefinite Programming, Sum-of-Squares Hierarchies and Combinatorial Optimization

Sunday, October 28, 2018

09:45 - 10:30: Fatih Demirkale (Yıldız Technical University, Istanbul)
Anti-Pasch Maximal Partial Triple Systems

10:30 - 11:15: Şule Yazıcı (Koç University, Istanbul)
Embedding Partial Latin Squares into Sets of MOLS

11:15 - 12:00: Sibel Özkan (Gebze Technical University, Kocaeli)
On Resolvable Cycle Decompositions

12:00 - 13:30: Lunch

13:30 - 14:30 (*Special Lecture*): Cem Güneri (Sabancı University, Istanbul)
On Linear Complementary Pair of Codes

14:30 - 15:15: Elif Segah Öztaş (Karamanoğlu Mehmetbey University, Karaman)
Algebraic Coding Theory, DNA codes

15:15 - 15:30: Coffee Break

15:30 - 16:15: Oktay Ölmez (Ankara University, Ankara)
Difference Set Methods and Their Links to Codes

16:15 - 17:00: Ezgi Kantarcı (University of Southern California, US)
Connecting Peak and Descent Polynomials

17:30: Dinner

Place: IMBM Seminar Room, Boğaziçi University South Campus

IMBM Discrete Mathematics Days, October 27-28

Below you may find the abstracts of the talks for IMBM Discrete Mathematics Days to be held on October 27-28, 2018. Please visit the relevant web page:

`https://sites.google.com/site/umitislak/imbmdiscretemathdaysfall2018`

for possible changes. We would like to express our gratitude to İstanbul Matematiksel Bilimler Merkezi for all the support they provided.

Organization Committee: Fatih Demirkale, Ümit Işlak

Scientific Committee: Aysel Erey, Müge Taşkın Aydın, Tınaz Ekim Aşıcı, Selda Küçükçifçi, Kağan Kurşungöz, Sibel Özkan, Şule Yazıcı

ABSTRACTS

Müge Taşkın Aydın - Boğaziçi University, İstanbul, Turkey.

Combinatorics of Young and Tower Diagrams. In this talk we will focus on combinatorics of Young diagrams and Tower diagrams. Young diagrams are one of the most well known objects in algebraic combinatorics due to their role in the representation theory of symmetric group and Schubert calculus of Grassmannian varieties. On the other hand Tower diagrams was first introduced in the work by M.Taşkın and O.Coşkun (2013) as a candidate to study important problems appearing in the Schubert calculus of Flag varieties. In this talk we will explain some of the main algorithms on Young and Tower diagrams and discuss the natural connection between them.

Zafeirakis Zafeirakopoulos - Gebze Technical University, Kocaeli, Turkey.

Using Polyhedral Geometry in Combinatorics. Polyhedral geometry is a natural way to interpret problems involving linear constraints. A lot of discrete and combinatorial problems can be modeled as problems of counting lattice points in polytopes (i.e., linear Diophantine systems). In this talk we will first discuss how to model problems about graphs (integral flows, coloring), integer partitions (plane partitions, young tableaux), posets (linear extensions), computer science (scheduling, loop unfolding) and social sciences (voting theory) as problems about lattice points in polytopes. Then we will revisit Partition Analysis, the classical method of MacMahon for solving linear Diophantine systems, from a geometric perspective.

Mohan Ravichandran - Mimar Sinan University, İstanbul, Turkey.

Counting Independent Sets in Graphs and Hypergraphs. Counting the number of independent sets of a graph is, unless further assumptions are made, a basic example of an computationally intractable problem. If one instead asks for approximation algorithms, several things can be said. The natural setting for this is to look at the so called independence polynomial of the graph, $I_G(x) = \sum_{I \subset V, I \ independent} x^{|I|}$ and ask when it can be approximately evaluated. Note that when $x = 1$, we count the number of independent sets.

To make the problem tractable, it is natural to focus on graphs with maximum degree bounded by a fixed number. It then turns out that for small values of x, $I_G(x)$ can be 'well approximated' while for large values of x, good approximations are 'hard'. This problem is particularly interesting as it can be approached via several different techniques, notably MCMC based techniques (Path coupling), probabilistic techniques (the so called method of correlation decay) as well as analytic techniques (the Barvinok interpolation method).

The situation for graphs is now well understood : However, the situation for hypergraphs is very poorly so. I will end with discussing the state of the art. This talk will be expository and be entirely devoted to the work of several mathematicians including Dyer-Frieze, Weitz, Vigoda-Tetali, Sly-Sun, Barvinok, Patel-Regts, Harmon-Sly-Zhang and Moitra.

Yusuf Civan - Süleyman Demirel University, Isparta, Turkey.

Castelnuovo-Mumford Regularity of Graphs. I will survey recent advances on the calculation of (Castelnuovo-Mumford) regularity of graphs. This will include the characterization of graph classes where exact computation is possible, the description of various upper/lower bounds on the regularity arising from related (matching/covering) parameters of graphs, the realization problem, and the theory of prime graphs. (Joint work with Türker Bıyıkoğlu)

Hamza Yeşilyurt - Bilkent University, Ankara, Turkey.

Shifted and Shiftless Partition Identities. For a subset R of natural numbers, let $p(R, n)$ denote the number of partitions of n with parts in R. An a-shifted identity is of the form $p(S, n) = p(T, n - a)$. In all known examples the sets S and T are unions of arithmetic progressions modulo an integer. Modular transformation of a given identity leads to another identity or a shiftless partition identity which are of the form $p(S, n) = p(T, n)$ for all but a fixed value of n. We will show how theta function identities can be used to prove such identities. (Joint work with Frank Garvan)

Kağan Kurşungöz - Sabancı University, İstanbul, Turkey.

Andrews-Gordon Type Series for Capparelli's Identities, Kanade-Russell Conjectures, and Schur's Identity. Andrews-Gordon identities is a milestone in the intersection of integer partitions and q-series. They are the q-series companions to Rogers-Ramanujan-Gordon identities. Besides their elegance, both partition theoretic aspects and q-series methods are essential in their proof unlike any other identity hitherto discovered. After the review of some basics, we will give a recent alternative construction for Andrews-Gordon identities themselves, and present their counterparts for Capparelli's identities (which were independently constructed by Kanade and Russell), Kanade-Russell conjectures, and Schur's identity.

Jehanne Dousse - CNRS and Universitý Lyon 1, France.

A Combinatorial Approach to Partition Identities from Representation Theory. A partition of a positive integer n is a non-increasing sequence of positive integers whose sum is n. A Rogers-Ramanujan type identity is a theorem stating that for all n, the number of partitions of n satisfying some difference conditions equals the number of partitions of n satisfying some congruence conditions. Lepowsky and Wilson were the first to exhibit a connection between Rogers-Ramanujan type partition identities and representation theory in the 1980's, followed by Capparelli and others. This gave rise to many interesting new identities unknown to combinatorialists. In this talk, I will present a combinatorial approach to refine and generalise such partition identities.

Ali Kemal Sinop - TOBB University of Economics and Technology, Ankara, Turkey.

Semidefinite Programming, Sum-of-Squares Hierarchies and Combinatorial Optimization. In the past two decades, semidefinite programming based relaxations have been successfully used for designing approximation algorithms with best known guarantees for many combinatorial optimization problems of practical interest; such as maximum cut, sparsest cut, coloring and so on. However the limitations of such approaches have become clear with the design of integrality gaps for these problems. In order to get around this issue, different hierarchies of increasingly stronger relaxations have been proposed. Sum-of-squares hierarchy (also known as the Lasserre-Parillo hiearchy) is one of the strongest known hierarchy of relaxations. Despite their potential, analyzing the integrality gap of these hierarchies have been a notoriously difficult problem. In this talk, I will present an overview of the recent results concerning these hierarchies from both a positive (algorithmic) and negative (integrality gap) perspective.

Fatih Demirkale - Yıldız Technical University, İstanbul, Turkey.

Anti-Pasch Maximal Partial Triple Systems. In this talk, firstly, the background of maximal partial triple systems will be given. Then, an enumeration algorithm of these structures will be explained. It will be shown that, up to isomorphism, there are 35 810 097 optimal maximal partial triple systems on 17 points and 47 744 568 maximal partial triple systems on 16 points. Structural properties of all these systems are determined, including their automorphism groups and the numbers of Pasch configurations. Also, it will be shown that for $v \neq 6, 7, 10, 11, 12, 13$ there exists a maximal partial triple system on v points that contains no Pasch configurations.

Şule Yazıcı - Koç University, İstanbul, Turkey.

Embedding Partial Latin Squares into Sets of MOLS. In 1960 Evans [2] proved that a partial Latin square of order n can always be embedded in some Latin square of order t for every $t \geqslant 2n$. In the same paper Evans asked if a pair of finite partial Latin squares which are orthogonal can be embedded in a pair of finite orthogonal Latin squares. It is known, that a pair of orthogonal Latin squares of order n can be embedded in a pair of orthogonal Latin squares of order t if $t \geqslant 3n$, the bound of $3n$ being best possible. Jenkins [3], considered embedding a single partial Latin square in a Latin square which has an orthogonal mate. His embedding was of order t^2. Recently the first constructive polynomial embedding result for a pair of orthogonal partial Latin squares is given in [1].

We showed that any partial Latin square of order n can be embedded in a Latin square of order at most $16n^2$ which has at least $2n-1$ mutually orthogonal mates. We also showed that a pair of (partial) orthogonal Latin squares of order n can be embedded into a set of t mutually orthogonal Latin squares of order a polynomial with respect to n for any $t \geqslant 2$. Furthermore the constructions we provided, give a set of 9 MOLS(576). The maximum known size of a set of mutually orthogonal Latin squares of order 576 was given to be 8 in literature. (Joint work with D. M. Donovan and M. J. Grannell)

[1] D. M. Donovan and E, S. Yazici. A polynomial embedding of pairs of orthogonal partial Latin squares, J. Combin. Theory Ser A, 126:24–34, 2014.

[2] T. Evans. Embedding incomplete latin squares, Amer. Math. Monthly, 67:958-961, 1960.

[3] P. Jenkins. Embedding a latin square in a pair of orthogonal latin squares, J. Combin. Des. 14:270–276, 2005.

Sibel Özkan - Gebze Technical University, Kocaeli, Turkey.

On Resolvable Cycle Decompositions. A *decomposition* of a graph G is a set $\mathcal{H} = \{H_1, H_2, ..., H_k\}$ of edge-disjoint subgraphs of G such that $\bigcup_{i=1}^{k} E(H_i) = E(G)$. If each H_i is a cycle, then $\mathcal{H}$ is called a *cycle decomposition.* Graph decompositions give us good connections between graph and design theory. Among graph decomposition problems, cycle decomposition is an the interesting and well-studied one. Especially, requirement of having parallel classes for a resolvable decomposition adds a good flavor and difficulty to the problem. The well-known resolvable cycle decomposition (a.k.a 2-factorization) problems are Hamilton cycle decompositions, Oberwolfach and the Hamilton-Waterloo problems. Here I will talk about these problems and give a few interesting constructions.

Cem Güneri - Sabancı University, İstanbul, Turkey.

On Linear Complementary Pair of Codes. Linear complementary pair (LCP) of codes have drawn much attention lately due to their applications in cryptography (particularly against side channel and fault injection attacks). This talk will briefly motivate the cryptographic interest and then present some of the main results and recent findings on this class of codes. Necessary definitions and notions will be introduced to make the talk suitable for general audience.

Elif Segah Öztaş - Karamanoğlu Mehmetbey University, Karaman, Turkey.

Algebraic Coding Theory, DNA codes. Coding Theory are studied by various scientific disciplines (information theory, electrical engineering, mathematics, linguistics, and computer science). The main purpose of codes is designing efficient and reliable data transmission methods. Algebraic Coding Theory (ACT) is in sub-field of coding theory. The properties of ACT codes are expressed in algebraic terms. Then, new researches are continued over new algebraic structures and applications over different areas such as DNA codes. New applications and creating correspondences over DNA codes are worked since 1994. In this talk, we will mention the aim of algebraic coding theory and applications to DNA codes. Also, some of the current problems and future works over different structures will be presented.

Oktay Ölmez - Ankara University, Ankara, Turkey.

Difference Set Methods and Their Links to Codes. In today's technology, many online applications require storing of data in a communication network and making this data readily available to multiple users. These applications include biometric identification, e-commerce, health and social services and banking which rely on significant mathematical methods to provide distributed storage and security. Evolving nature of this digital world also imposed several new mathematical problems in the area of Coding theory, and Cryptography over the decades. Conducting research on these type problems provided a general understanding of Discrete Mathematics and resulted in new interesting applications.

Combinatorial design theory is undoubtedly one of the main characters in this progress. For instance, combinatorial designs served as a powerful tool to construct codes which transmit quickly, contain many valid code words and can correct or at least detect many errors. A well-known example arises from generator matrix of Golay Code [23,12,7] which can be obtained uniquely from the 2-(11,6,3) design. Another example is Low Density Parity Check (LDPC) codes. These codes used in data modems, telephone transmissions, and the NASA Deep Space Network.

We will focus on designs with prescribed automorphisms. A main construction method of combinatorial designs with nice symmetries is known as difference set method. Difference set method has attracted many researchers from different fields since this method provides elegant solutions to application problems related to error correcting codes, graphs and cryptographic functions. In this talk we will explore the links between difference set methods and codes.

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Ezgi Kantarcı - University of Southern California, Los Angeles, US.

Connecting Peak and Descent Polynomials. Denote by $d(S, n)$ the number of permutations of n with a given descent set S. This is a polynomial in n, called the descent polynomial. An analogous construction for the peak statistic, adjusted by a power of 2 gives us the peak polynomial $p(I, n)$. In this talk, we tie the theory of peak and descent polynomials together by giving a binary expansion of $d(S, n)$ in terms of peak polynomials. We then define involutions on permutations that give a combinatorial interpretation for the coefficients of $p(I, n)$ in a binomial basis centered at $\max(I)$.
