

The 22nd KIAS Combinatorics Workshop

Shilla Stay Haeundae
Busan, Korea

December 19–22, 2018

Information

Title: The 22nd KIAS Combinatorics Workshop

Date: December 19–22, 2018

Venue: Shilla Stay Haeundae, Busan, Korea

Web: events.kias.re.kr/h/combinatorics/?pageNo=3590

Invited Speaker

Patrick Ali (Yeungnam University)

Hyung-Chan An (Yonsei University)

Yandong Bai (Northwestern Polytechnical University)

Jeong-Ok Choi (GIST)

Jisun Huh (Ajou University)

Jong Yoon Hyun (KIAS)

Dongyeap Kang (KAIST)

Jaehoon Kim (University of Warwick)

Ringi Kim (KAIST)

Younjin Kim (Ewha Womans University)

Sang June Lee (Duksung Women's University)

Sejin Oh (Ehwa Womans University)

Boram Park (Ajou University)

Seonjeong Park (Ajou University)

Younghwan Son (POSTECH)

Organizers

Jong Yoon Hyun (KIAS)

Jang Soo Kim (Sungkyunkwan University)

Jeong Han Kim (KIAS)

Seog-Jin Kim (Konkuk University)

Young Soo Kwon (Yeungnam University)

Sang June Lee (Duksung Women's University)

Seunghyun Seo (Kangwon National University)

Timetable

December 19 (Wednesday)		
14:30 – 15:00	Registration	
Chair: Young Soo Kwon (Yeungnam University)		
15:00 – 15:40	Jeong-Ok Choi	Contagion threshold in finite networks: effects of heterogeneity of degree distribution, clustering, and bilingual option
15:50 – 16:30	Ringi Kim	Ramsey-type theorems for various classes of graphs
16:30 – 17:00	Coffee break	
17:00 – 17:40	Seonjeong Park	Real toric varieties defined by graphs
18:00 –	Dinner	

December 20 (Thursday)		
09:40 – 10:00	Coffee break	
Chair: Seungjin Lee (Seoul National University)		
10:00 – 10:40	Hyung-Chan An	Recent Developments in Approximation Algorithms for the s-t Path TSP and Other Variants
10:50 – 11:30	Younghwan Son	Joint ergodicity along generalized linear functions
11:30 – 13:30	Lunch	
Chair: Seunghyun Seo (Kangwon National University)		
13:30 – 14:10	Sang June Lee	Infinite Sidon sets contained in sparse random sets of integers
14:20 – 15:00	Jaehoon Kim	Rainbow subgraphs and Latin squares
15:10 – 15:50	Yandong Bai	Disjoint cycles in digraphs
15:50 – 16:10	Coffee break	
16:10 – 18:00	Problem Session	
18:00 –	Dinner	

December 21 (Friday)		
09:40 – 10:00	Coffee break	
Chair: Heesung Shin (Inha University)		
10:00 – 10:40	Sejin Oh	Level ℓ representations of affine Kac–Moody algebras of rank n and families of partitions in the square $n \times \ell$
10:50 – 11:30	Jisun Huh	A bijection between self-conjugate and ordinary partitions
11:30 – 13:30	Lunch	
Chair: Ilkyoo Choi (Hankuk University of Foreign Studies)		
13:30 – 14:10	Boram Park	On toric ideals of signed graphs
14:20 – 15:00	Younjin Kim	On conjectures in Ramsey Turan Theory
15:00 – 15:30	Coffee break	
15:30 – 16:10	Patrick Ali	Bounds on the Steiner distance of a graph
18:00 –	Banquet	

December 22 (Saturday)		
09:40 – 10:00	Coffee break	
Chair: Jongyook Park (Wonkwang University)		
10:00 – 10:40	Jong Yoon Hyun	A proof of the conjecture for the extension theorem on combinatorial metrics
10:50 – 11:30	Dongyeap Kang	Some extremal results on highly connected tournament-like digraphs
11:30 – 13:00	Lunch	

Speaker: Jeong-Ok Choi

Affiliation: GIST

Title: Contagion threshold in finite networks: effects of heterogeneity of degree distribution, clustering, and bilingual option

Abstract

We introduce a natural extension of the contagion thresholds for finite graphs, which were defined for infinite regular graphs (in [1]). We consider two-dimensional regular lattices (i.e., Cartesian product of two paths), regular random networks (RRNs), and two kinds of scale-free networks (SFNs) with and without the bilingual option. Without the bilingual option, degree inhomogeneity and clustering enhance the contagion threshold in non-regular networks except for those with an unrealistically small average degree. We provide a plausible explanation for the results using the friendship paradox and *detour effect*. The contagion threshold of regular random networks is almost the same as that of the regular trees, which is the minimum among regular networks. We show that the contagion threshold increases by clustering with a low-cost bilingual option.

[1] N. Immorlica and J. Kleinberg and M. Mahdian and T. Wexler, *The Role of Compatibility in the Diffusion of Technologies Through Social Networks*, Proceedings of the 8th ACM Conference on Electronic Commerce (2007), 75–83.

Speaker: Ringi Kim

Affiliation: KAIST

Title: Ramsey-type theorems for various classes of graphs

Abstract

Ramsey's theorem asserts that every sufficiently large graph contains a large complete graph or its complement as an induced subgraph. There are several results similar to Ramsey's theorem. Some of these results state that a sufficiently large graph satisfying certain conditions contains a well-structured large graph satisfying the same conditions. A theorem of this kind is called a Ramsey-type theorem. In this talk, we introduce some Ramsey-type theorems recently developed.

Speaker: Seonjeong Park

Affiliation: Ajou University

Title: Real toric varieties defined by graphs

Abstract

The h -vector of a simple polytope is a fundamental invariant of the polytope which encodes the number of faces of different dimensions, and if a simple polytope P defines a projective smooth toric variety $X(P)$, then the i th Betti number of $X(P)$ equals $h_i(P)$. For a simple graph G , a graph associahedron Δ_G and a graph cubeahedron \square_G are simple convex polytopes which define projective smooth toric varieties $X(\Delta_G)$ and $X(\square_G)$, respectively. Furthermore, the h -vectors of graph associahedra give interesting integer sequences. The real locus of a toric variety is called a real toric variety. In this talk, we are more interested in the real toric varieties $X^{\mathbb{R}}(\Delta_G)$ and $X^{\mathbb{R}}(\square_G)$. The Betti numbers of $X^{\mathbb{R}}(\Delta_G)$ and $X^{\mathbb{R}}(\square_G)$ are determined by some graph invariants, a -numbers and b -numbers, and they also give interesting integer sequences. Furthermore, for a forest G and its line graph $L(G)$, the real toric varieties $X^{\mathbb{R}}(\Delta_G)$ and $X^{\mathbb{R}}(L(G))$ have the same Betti numbers. I will also introduce several open problems related to the real toric varieties defined by graphs.

This is based on joint work with Boram Park and Hanchul Park.

Speaker: Hyung-Chan An

Affiliation: Yonsei University

Title: Recent Developments in Approximation Algorithms for the s - t Path TSP and Other Variants

Abstract

최근 s - t 경로 외판원 문제 (s - t path traveling salesman problem, 이하 s - t path TSP)에 대한 근사 알고리즘을 개선하는 연구가 다수 이루어졌다. 이 s - t path TSP는 두 정점 s 와 t 를 포함한 정점들 상의 거리함수가 입력으로 주어질 때, s 에서 시작하여 모든 정점을 지나 t 에 도달하는 경로 중 가장 짧은 것을 찾는 것을 목표로 하는 문제이다. 1991년 Hoogeveen에 의해 Christofides-Serdyukov 알고리즘이 s - t path TSP에 대한 $5/3$ -근사 알고리즘임이 증명된 이래, 이보다 나은 근사비를 갖는 알고리즘은 극히 최근에야 알려지기 시작하였다.

본 강연에서는 우선, s - t path TSP에 대하여 Christofides-Serdyukov 알고리즘을 처음 개선한 $\frac{1+\sqrt{5}}{2}$ -근사 알고리즘(2012년)을 시작으로 $3/2$ -근사 알고리즘(2019년)에 이르기까지 최근 수년 간 발전된, 선형계획법에 기반한 알고리즘적 기법들을 살펴보고 남아 있는 미해결 문제를 조사한다. 본 강연의 후반에서는 외판원 문제의 변형 중 하나인 병목 비대칭 외판원 문제 (bottleneck asymmetric TSP)와 이에 관련된 미해결 문제를 소개할 것이다.

Speaker: Younghwan Son

Affiliation: POSTECH

Title: Joint ergodicity along generalized linear functions

Abstract

Ergodic theory concerns the long-term behavior of dynamical systems. Initiated by Furstenberg, the study of limiting behavior of multiple ergodic averages provides new methods to investigate combinatorial structures of densely large subsets of integers.

In this talk, we will present some results and problems in combinatorial number theory and we will discuss ergodic approach to some of these results. Then we will present some recent results on joint ergodicity of multiple ergodic averages.

This is a joint work with V. Bergelson and A. Leibman.

Speaker: Sang June Lee

Affiliation: Duksung Women's University

Title: Infinite Sidon sets contained in sparse random sets of integers

Abstract

A set S of natural numbers is a *Sidon set* if all the sums $s_1 + s_2$ with $s_1, s_2 \in S$ and $s_1 \leq s_2$ are distinct. Let constants $\alpha > 0$ and $0 < \delta < 1$ be fixed, and let $p_m = \min\{1, \alpha m^{-1+\delta}\}$ for all positive integers m . Generate a random set $R \subset \mathbb{N}$ by adding m to R with probability p_m , independently for each m . We investigate how dense a Sidon set S contained in R can be. Our results show that the answer is qualitatively very different in at least three ranges of δ . We prove quite accurate results for the range $0 < \delta \leq 2/3$, but only obtain partial results for the range $2/3 < \delta \leq 1$.

This is joint work with Y. Kohayakawa, C. G. Moreira and V. Rödl.

Speaker: Jaehoon Kim

Affiliation: University of Warwick

Title: Rainbow subgraphs and Latin squares

Abstract

We say a subgraph H of an edge-colored graph is rainbow if all edges in H has distinct colors. The concept of rainbow subgraphs generalizes the concept of transversals in latin squares. In this talk, we discuss how these concepts are related and we introduce a result regarding approximate decompositions of graphs into rainbow subgraphs. This has implications on transversals in latin square.

It is based on a joint work with Kühn, Kupavskii and Osthus.

Speaker: Yandong Bai

Affiliation: Northwestern Polytechnical University

Title: Disjoint cycles in digraphs

Abstract

Bermond and Thomassen conjectured in 1981 that every digraph with minimum out-degree at least $2k - 1$ contains k vertex-disjoint cycles, where k is a positive integer. It is famous as one of the one hundred unsolved problems selected in [Bondy, Murty, Graph Theory, Springer-Verlag London, 2008]. Lichiardopol, Por and Sereni proved in [SIAM J. Discrete Math. 23 (2) (2009) 979-992] that the above conjecture holds for $k = 3$.

Let g be the girth, i.e., the length of the shortest cycle, of a given digraph. Bang-Jensen, Bessy and Thomassé conjectured in [J. Graph Theory 75 (3) (2014) 284-302] that every digraph with girth g and minimum outdegree at least $\frac{g}{g-1}k$ contains k vertex-disjoint cycles. Thomassé conjectured around 2005 that every oriented graph (a digraph without 2-cycles) with girth g and minimum outdegree at least h contains a path of length $h(g - 1)$, where h is a positive integer.

In this talk, we first present a new shorter proof of the Bermond-Thomassen conjecture for the case of $k = 3$, and then we disprove the conjecture proposed by Bang-Jensen, Bessy and Thomassé. Finally, we disprove the even girth case of the conjecture proposed by Thomassé.

Speaker: Sejin Oh

Affiliation: Ewha Womans University

Title: Level ℓ representations of affine Kac-Moody algebras of rank n and families of partitions in the square $n \times \ell$

Abstract

In this talk, I would like to introduce dominant maximal weights of integrable representations of affine Kac-Moody algebras. Even though the dimensions of such representations are infinite, the numbers of dominant maximal weights are finite. Using partitions in the square determined by rank-level, we can enumerate the numbers of dominant maximal weights for all integrable representation explicitly. With the formulas at hand, we have interesting applications in aspects of representation theory and combinatorics theory.

This is joint work of Young-Hun Kim and Prof. Young-Tak Oh.

Speaker: Jisun Huh

Affiliation: Ajou University

Title: A bijection between self-conjugate and ordinary partitions

Abstract

In this talk, we give a bijection between the set of self-conjugate partitions and that of ordinary partitions, which shows a relation between hook lengths of self conjugate partitions and corresponding partitions. As a corollary, we give new combinatorial interpretations for the Catalan number and the Motzkin number in terms of self-conjugate simultaneous core partitions.

This is a joint work with Hyunsoo Cho and Jaebum Sohn.

Speaker: Boram Park

Affiliation: Ajou University

Title: On toric ideals of signed graphs

Abstract

A *signed graph* is a pair (G, τ) of a graph G and its sign τ , where a *sign* τ is a function from $\{(e, v) \mid e \in E(G), v \in V(G), v \in e\}$ to $\{1, -1\}$. Note that graphs or digraphs are special cases of signed graphs. In this paper, we study the toric ideal $I_{(G, \tau)}$ associated with a signed graph (G, τ) , and the results of the paper give a unified idea to explain some known results on the toric ideals of a graph or a digraph. We characterize all primitive binomials of $I_{(G, \tau)}$, and then focus on the complete intersection property. More precisely, we find a complete list of graphs G such that $I_{(G, \tau)}$ is a complete intersection for every sign τ .

The work is based on joint work with JiSun Huh and Sangwook Kim.

Speaker: Younjin Kim

Affiliation: Ewha Womans University

Title: On conjectures in Ramsey Turan theory

Abstract

Given graphs H_1, \dots, H_k , a graph G is (H_1, \dots, H_k) -free if there is a k -edge-colouring $\phi : E(G) \rightarrow [k]$ with no monochromatic copy of H_i with edges of colour i for each $i \in [k]$. Fix a function $f(n)$, the Ramsey-Turán function $RT(n, H_1, \dots, H_k, f(n))$ is the maximum number of edges in an n -vertex (H_1, \dots, H_k) -free graph with independence number at most $f(n)$. We determine $RT(n, K_3, K_s, \delta n)$ for $s \in \{3, 4, 5\}$ and sufficiently small δ , confirming a conjecture of Erdős and Sós from 1979.

This is a joint work with Jaehoon Kim and Hong Liu. In this talk, I also introduce recent developments and open problems in hypergraph Ramsey number.

Speaker: Patrick Ali

Affiliation: University of Malawi and Yeungnam University

Title: Bounds on the Steiner distance of a graph

Abstract

For a nonempty set S of vertices of a connected graph G of order p , the distance $d(S)$ of S is the minimum size of a connected subgraph whose vertex set contains S . Let n be an integer such that $2 \leq n \leq p$. The n -diameter of G is defined to be the maximum Steiner distance of any n -subset of vertices of G and the n -radius is the minimum Steiner distance of any n -subset of its vertices. In this talk, we consider upper bounds on the n -diameter and n -radius.

Speaker: Jong Yoon Hyun

Affiliation: KIAS

Title: A proof of the conjecture for the extension theorem on combinatorial metrics

Abstract

The extension theorem on a combinatorial-metric states that for every combinatorial-weight preserving isomorphism between linear codes, there is a full isometric extension of it.

Pinheiro, Machado and Firer proposed, on the finite field of characteristic p , the problem of characterizing the combinatorial metrics satisfying the extension theorem and obtained a partial result for this characterization problem. In particular, they conjectured when $p = 2$ that a family of specific combinatorial weights satisfies the extension theorem.

In this talk, we present that the conjecture is not true in general and provide the complete description of combinatorial weights satisfying the extension theorem.

Speaker: Dongyeap Kang

Affiliation: KAIST

Title: Some extremal results on highly connected tournament-like digraphs

Abstract

The class of tournaments is one of the most studied classes in theory of digraphs. We discuss some recent extremal results on highly connected tournament-like digraphs, in perspective of partitioning of highly connected tournaments into well-structured subgraphs and finding a highly connected spanning subgraph with few edges. Both proofs utilize two main ideas on the robust linkage structure by Kühn, Lapinskas, Osthus and Patel (2014) and the sparse linkage structure by Kim, Kim, Suh and myself (2017).

This is based on joint work with Jaehoon Kim.

List of Participants

Ahn, Jungho	KAIST	hoeunsu1@kaist.ac.kr
Ali, Patrick	Yeungnam University	pali@cc.ac.mw
An, Hyung-Chan	Yonsei University	hyung-chan.an@yonsei.ac.kr
Bai, Yandong	Northwestern Polytechnical University	bai@nwpu.edu.cn
Cho, Eun-Kyung	Pusan National University	ekcho@pusan.ac.kr
Cho, Hyunsoo	Yonsei University	coconut@yonsei.ac.kr
Cho, Jaehyun	UNIST	petercho@unist.ac.kr
Choi, Ilkyoo	Hankuk University of Foreign Studies	ilkyoo@hufs.ac.kr
Choi, Jeong-Ok	GIST	jchoi351@gist.ac.kr
Chung, Sol	Seoul National University	taros@snu.ac.kr
Eoh, Soogang	Seoul National University	mathfish@snu.ac.kr
Eom, Taehyun	KAIST	taeheom@kaist.ac.kr
Hong, Taehee	Seoul National University	ds3mbc@snu.ac.kr
Huh, JiSun	Ajou University	hyunyjia@yonsei.ac.kr
Hwang, Byung-hak	Seoul National University	xoda@snu.ac.kr
Hyun, Jong Yoon	KIAS	hyun33@kias.re.kr
Jang, Jihyeug	Sungkyunkwan University	ab4242@skku.edu
Jung, Woo-Seok	Seoul National University	jungws@snu.ac.kr
Kang, Dongyeap	KAIST	dyk90@kaist.ac.kr
Kim, Byungchan	SeoulTech	bkim4@seoultech.ac.kr
Kim, Hyoungjun	Ewha Womans University	kimhjun@ewha.ac.kr
Kim, Jaehoon	University of Warwick	mutualteon@gmail.com
Kim, Jeonghan	KIAS	jhkim@kias.re.kr
Kim, Ringi	KAIST	ringikim2@gmail.com
Kim, Sangwook	Chonnam National University	swkim.math@gmail.com
Kim, Young-Hun	Sogang University	yhkim14@sogang.ac.kr
Kim, Younjin	Ewha Womans University	younjinkim@ewha.ac.kr

Kwak, Minki	Seoul National University	mnicebabyk@snu.ac.kr
Kwon, Young Soo	Yeungnam University	ysookwon@ynu.ac.kr
Lee, Dabeen	Carnegie Mellon University	dabeenl@andrew.cmu.edu
Lee, Deok Sang	KAIST	ejrtkd0412@kaist.ac.kr
Lee, Sang June	Duksung Women's University	sjlee242@gmail.com
Lee, Seungjin	Seoul National University	lsjin@snu.ac.kr
Nam, Sunyoung	Sogang University	synam.math@gmail.com
No, Sungjong	Korea University	sungjongno84@gmail.com
O, Suil	The State University of New York, Korea	suil.o@stonybrook.edu
Oh, Jaeseong	Seoul National University	jaeseong_oh@snu.ac.kr
Oh, Sejin	Ewha Womans University	sejin092@gmail.com
Oum, Sang-il	IBS/KAIST	sangil@kaist.edu
Park, Boram	Ajou University	borampark22@gmail.com
Park, Jihye	Yeungnam University	spybow@hanmail.net
Park, Jongyook	Wonkwang University	jongyook@wku.ac.kr
Park, Seonjeong	Ajou University	seonjeong1124@gmail.com
Seo, Seunghyun	Kangwon National University	shyunseo@kangwon.ac.kr
Seong, Hahye	Korea University	hh5seong@korea.ac.kr
Shin, Heesung	Inha University	shin@inha.ac.kr
Shin, Yongho	Yonsei University	syh5477@gmail.com
Sohn, Jaebum	Yonsei University	jsohn@yonsei.ac.kr
Son, Younghwan	POSTECH	yhson@postech.ac.kr
Yoo, Hyungkee	Korea University	lpyhk727@korea.ac.kr
Yoon, Hyesun	Seoul National University	magisakura@snu.ac.kr
Yoon, Sungchul	Seoul National University	math_yoon@naver.com
Yu, Sanghoon	Seoul National University	ysh4017@snu.ac.kr
Yun, Sun-mi	Sungkyunkwan University	sera314@gmail.com