The 34th KIAS Combinatorics Workshop

Jeju, Korea
May 29-31, 2025

Information

Title: The 34th KIAS Combinatorics Workshop

Date: May 29-31, 2025

Venue: Uni Hotel, Jeju

Web: http://events.kias.re.kr/h/combinatorics/ or kcws.combinatorics.kr

Invited Speakers

Kiryong Chung (Kyungpook National University)

Zichao Dong (IBS ECOPRO)

Donggun Lee (IBS CCG)

Meike Hatzel (IBS DIMAG)

Hyobeen Kim (G-LAMP, Chonnam National University)

Doowon Koh (Chungbuk National University)

Seonjeong Park (Jeonju University)

Minho Song (Sungkyunkwan University)

Organizers

Jaehoon Kim (KAIST)

Jang Soo Kim (Sungkyunkwan University)

Jeong Han Kim (KIAS)

Seog-Jin Kim (Konkuk University)

Young Soo Kwon (Yeungnam University)

Sang June Lee (Kyung Hee University)

Jongyook Park (Kyungpook National University)

Seunghyun Seo (Kangwon National University)

<Time Table>

1st Day: May 29 (Thursday)		
15:00 ~ 16:00	Registration and Opening	
16:00 ~ 17:30	Session (A)	
Chair: Seog-Jin Kim		
16:00 ~ 16:40	Doowon Koh	The Erdős-Falconer distance problem for arbitrary sets in F_q^d and point sets on an affine subspace over finite fields
16:50 ~ 17:30	Hyobeen Kim	The complexity of adaptably k-colouring for edge-coloured hypergraphs
18:00 ~	Dinner	

2nd Day: May 30 (Friday)		
~ 09:30	Breakfast	
09:30 ~ 12:00	Session (B)	
Chair: Seunghyun Seo		
09:30 ~ 10:10	Donggun Lee	Characteristic polynomial of the moduli space of pointed rational curves and log-concavity
10:20 ~ 11:00	Minho Song	A unified combinatorial framework for orthogonal polynomials including type R_{II}
11:00 ~ 11:20	Coffee Break	
11:20 ~ 12:00	Seonjeong Park	Combinatorial characterization of the smoothness of the intersection of Schubert varieties and Hessenberg varieties
12:00 ~ 14:00	Lunch	
14:00 ~ 17:30	Free discussion	
18:00 ~	Banquet	

3rd Day: May 31 (Saturday)		
~ 09:30	Breakfast	
09:30 ~ 12:00	Session (C)	
Chair: Young Soo Kwon		
09:30 ~ 10:10	Kiryong Chung	Counting of rational curves
10:20 ~ 11:00	Meike Hatzel	Strongly sublinear separators and bounded asymptotic dimension for sphere intersection graphs
11:00 ~ 11:20	Coffee Break	
11:20 ~ 12:00	Zichao Dong	Set families: restricted distances via restricted intersections
12:00 ~	Closing and Lunch	

Speaker: Doowon Koh

Affiliation: Chungbuk National University

Title: The Erdős-Falconer distance problem for arbitrary sets in $\mathbb{F}_q^d$ and point sets on an affine subspace over finite fields

Abstract
In this talk, we study the cardinality of the distance set determined by a set $A \subset \mathbb{F}_q^d$ and a set B lying in a k dimensional affine subspace over finite fields. Assuming that the set B lies in a k-coordinate plane under translations and rotations, we show that if $|A||B| > 2q^d$, then $|\Delta(A,B)| > \frac{q}{2}$, where $|\Delta(A,B)|$ denotes the number of elements in the distance set determined by A and B. In particular, we show that our result implies the sharp $(d+1)/2$ result for the Erdős-Falconer distance problem, where distances are determined by a single set in odd dimensions. Moreover, by another interesting application of our theorem, we improve the results on the Box distance problem by Borges, Iosevich, and Ou.

Speaker: Hyobeen Kim

Affiliation: G-LAMP, Chonnam National University

Title: The complexity of adaptably k-colouring for edge-coloured hypergraphs

Abstract
Given an r-uniform hypergraph G and a colouring $p : E(G) \to [k]$ of the hyperedges with up to k-colours, an adapted k-coloring of (G, p) is a vertex map $\phi : V(G) \to [k]$ such that for every hyperedge e, there is some vertex in e such that $\phi(v) \neq p(e)$. We show that for $k, r \geq 2$, the problem of deciding if an instance edge coloured graph (G, p) has an adapted k-colouring is NP-complete unless $(k, r) = (2, 2)$. In this last case, we show that the problem is polynomial time solvable.

Speaker: Donggun Lee

Affiliation: IBS CCG

Title: Characteristic polynomial of the moduli space of pointed rational curves and log-concavity

Abstract
Motivated by Stanley's generalization of the chromatic polynomial of a graph to the chromatic symmetric function, we introduce the characteristic polynomial of a symmetric function, or equivalently, of a representation of the symmetric group, defined via principal specialization. This polynomial appears to share one of the most interesting features of the chromatic polynomial, log-concavity, especially when it arises from the cohomology of an algebraic variety.

From the perspective of matroid theory, the moduli space of pointed rational curves may be viewed as the wonderful compactification of the complement of the braid arrangement, whose cohomology equals the Chow ring of the graphic matroid of the complete graph (with respect to the minimal building set). This moduli space carries a natural action of the symmetric group permuting the marked points, inducing a graded representation on its cohomology.

I will propose several log-concavity conjectures for the associated bivariate polynomial, supported by numerical evidence and asymptotic formulas derived from our combinatorial and recursive descriptions of the graded representation.

Based on joint works with Prof. Jinwon Choi and Young-Hoon Kiem.

Speaker: Minho Song

Affiliation: Sungkyunkwan University

Title: A unified combinatorial framework for orthogonal polynomials including type R_{II}

Abstract
In 1995, Ismail and Masson introduced orthogonal polynomials of types R_I and R_{II}, characterized by specific three-term recurrence relations with additional conditions. Recently, Kim and Stanton provided a combinatorial model for the moments of type R_I orthogonal polynomials, the combinatorial theory of orthogonal polynomials due to Flajolet and Viennot.

Motivated by the search for similar interpretations in the type R_{II} case, this talk develops a generalized combinatorial framework for orthogonal polynomials defined by extended recurrence relations. By relaxing structural constraints, we unify the combinatorial interpretations of moments across a broad range of families: classical orthogonal polynomials, Laurent biorthogonal polynomials, and types R_I and R_{II}. A central result is a master theorem that connects weighted lattice paths to moment sequences in these settings.

This is joint work with Jang Soo Kim.

Speaker: Seonjeong Park

Affiliation: Jeonju University

Title: Combinatorial characterization of the smoothness of the intersection of Schubert varieties and Hessenberg varieties

Abstract
A regular semisimple Hessenberg variety $Hess(S, h)$ is a smooth subvariety of $Fl(n)$, defined by a Hessenberg function h and a diagonal matrix S. In this talk, we investigate the smoothness of the intersection of $Hess(S, h)$ with a Schubert variety X_w. I will present two combinatorial characterizations of this smoothness: one in terms of graphs, and the other in terms of pattern avoidance determined by h. Each provides a sufficient condition for Hessenberg–Schubert varieties to be smooth.

Speaker: Kiryong Chung

Affiliation: Kyungpook National University

Title: Counting of rational curves

Abstract
A curve that can be parameterized by a polynomial (or its fraction) is called a rational curve. In algebraic geometry, there has been much interest in the geometry of this curve. In this talk, I would like to introduce the history of rational curves and the problem of counting the number of rational curves with specific geometric conditions.

Speaker: Meike Hatzel

Affiliation: IBS DIMAG

Title: Strongly sublinear separators and bounded asymptotic dimension for sphere intersection graphs

Abstract
The *sphere dimension* of a graph G is the smallest integer $d \geq 2$ so that G is an intersection graph of metric spheres in $\mathcal{R}^d$. This talk considers the class $\mathcal{C}^d$ of graphs with sphere dimension d. We present the results that for each integer t, the class of all graphs in $\mathcal{C}^d$ that exclude $K_{t,t}$ as a subgraph has strongly sublinear separators and that $\mathcal{C}^d$ has asymptotic dimension at most $2d + 2$. The presented work is joined with James Davies, Agelos Georgakopoulos and Rose McCarty.

Speaker: Zichao Dong

Affiliation: IBS ECOPRO

Title: Set families: restricted distances via restricted intersections

Abstract
Denote by $f_D(n)$ the maximum size of a set family $\mathcal{F}$ on $[n] \stackrel{\text{def}}{=} \{1, \ldots, n\}$ with distance set D. That is, $|A \triangle B| \in D$ holds for every pair of distinct sets $A, B \in \mathcal{F}$. Kleitman's celebrated discrete isodiametric inequality states that $f_D(n)$ is maximized at Hamming balls of radius $d/2$ when $D = \{1, \ldots, d\}$. We study the generalization where D is a set of arithmetic progression and determine $f_D(n)$ asymptotically for all homogeneous D. In the special case when D is an interval, our result confirms a conjecture of Huang, Klurman, and Pohoata. Moreover, we demonstrate a dichotomy in the growth of $f_D(n)$, showing linear growth in n when D is a non-homogeneous arithmetic progression. Different from previous combinatorial and spectral approaches, we deduce our results by converting the restricted distance problems to restricted intersection problems.

Our proof ideas can be adapted to prove upper bounds on t-distance sets in Hamming cubes (also known as binary t-codes), which has been extensively studied by algebraic combinatorialists community, improving previous bounds from polynomial methods and optimization approaches.

List of Participants

No.	Name	Affiliation	E-mail
1	Jisun Baek	Yonsei University	baek_jisun@yonsei.ac.kr
2	Sejeong Bang	Yeongnam University	sjbang@ynu.ac.kr
3	Jihyo Chae	Yonsei University	jihyochae@yonsei.ac.kr
4	Yeonsu Chang	Hanyang University	yeonsu@hanyang.ac.kr
5	Minho Cho	KIAS	minhocho.math@gmail.com
6	ILKYOO CHOI	Hankuk University of Foreign Studies	ilkyoo@hufs.ac.kr
7	Mujin Choi	KAIST & IBS DIMAG	mujinchoi@kaist.ac.kr
8	Hojin Chu	Kias	hojinchu@kias.re.kr
9	Kiryong Chung	Kyungpook National University	krchung@knu.ac.kr
10	Zichao Dong	Institute for Basic Science, ECOPRO	zichao@ibs.re.kr
11	Taehyun Eom	Chonnam National University	taeheom@alumni.kaist.ac.kr
12	Niloufar Fuladi	Inria center of university of Lorraine	niloufar.fuladi@aol.com
13	Meike Hatzel	IBS DIMAG	research@meikehatzel.com
14	Cheolwon Heo	SUNY Korea	cheolwon.heo@stonybrook.edu
15	Taehee Hong	Seoul National University	ds3mbc@snu.ac.kr
16	Bokhee IM	Chonnam N. Univ.	bim@jnu.ac.kr
17	Seonghyuk Im	KAIST/IBS ECOPRO	seonghyuk@kaist.ac.kr
18	Gunwoo Kim	KAIST & IBS DIMAG	gunwoo.kim@kaist.ac.kr
19	Ho Kim	KAIST	skyho@kaist.ac.kr
20	Hyobeen Kim	Chonnam National University	hbkim1029@chonnam.ac.kr

List of Participants

No.	Name	Affiliation	E-mail
21	Jeonghan Kim	KIAS	jhkim@kias.re.kr
22	Sangwook Kim	Chonnam National University	swkim.math@gmail.com
23	Seog-Jin Kim	Konkuk University	skim12@konkuk.ac.kr
24	Seokbeom Kim	KAIST & IBS DIMAG	seokbeom@kaist.ac.kr
25	Doowon Koh	Chungbuk National University	koh131@gmail.com
26	Hyemin Kwon	Kias	khmin1121@kias.re.kr
27	Young Soo Kwon	Yeungnam University	ysookwon@ynu.ac.kr
28	Donggun Lee	IBS-CCG	dglee@ibs.re.kr
29	Joonkyung Lee	Yonsei University	joonkyunglee@yonsei.ac.kr
30	Hyoyoon Lee	Sogang University	hyoyoonlee@sogang.ac.kr
31	Hyunwoo Lee	KAIST / IBS ECOPRO	hyunwoo.lee@kaist.ac.kr
32	Myounghwan Lee	Hanyang University	sycuel@hanyang.ac.kr
33	Ben Lund	Institute for Basic Science	ben.lund@ibs.re.kr
34	Sunyo Moon	KIAS	symoom@kias.re.kr
35	Semin Oh	Kyungpook National University	semin@knu.ac.kr
36	Sang-il Oum	IBS Discrete Mathematics Group	sangil@ibs.re.kr
37	Boram Park	Ajou University	borampark22@gmail.com
38	Hyemi Park	Hanyang University	gpal721@hanyang.ac.kr
39	Jeong Rye Park	Kyungpook National University	parkjr0628@gmail.com
40	Jihye Park	Yeungnam University	jihyepark@ynu.ac.kr

List of Participants

No.	Name	Affiliation	E-mail
41	Jongyook Park	Kyungpook National University	jongyook@knu.ac.kr
42	Seonjeong Park	Jeonju University	seonjeong1124@gmail.com
43	Homoon Ryu	Ajou University	ryuhomoon@ajou.ac.kr
44	Jaehyeon Seo	Yonsei University	jaehyeonseo@yonsei.ac.kr
45	Seunghyun Seo	Kangwon National University	shyunseo@kangwon.ac.kr
46	Roohani Sharma	IBS DIMAG	ysookwon@ynu.ac.kr
47	Heesung Shin	Inha University	shin@inha.ac.kr
48	Mark Siggers	KNU	mhsiggers@knu.ac.kr
49	SEOK-ZUN SONG	Jeju National University	szsong@jejunu.ac.kr
40	Minho Song	Sungkyunkwan University	smh3227@skku.edu
51	Sarah Wajsbrot	IBS DIMAG	sarah.wajsbrot@loria.fr