The 33rd KIAS Combinatorics Workshop

KIAS
Seoul, Korea
February 20–21, 2025

Contents

1 General Information

Title The 33rd KIAS Combinatorics Workshop

Date February 20–21, 2025

Venue KIAS, Seoul

Homepage `http://events.kias.re.kr/h/combinatorics/`

Invited Speakers

Jineon Baek (Yonsei University)

Cheolwon Heo (SUNY Korea)

Eng Keat Hng (IBS ECORPO)

Byung-Hak Hwang (KIAS)

Young-Hun Kim (SNU, QSMS)

Ander Lamaison (IBS ECOPRO)

Sunyo Moon (KIAS)

Meesue Yoo (CBNU)

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)

2   Schedule and Abstracts

1st Day: February 20 (Thursday)

13:00 - 14:00	Registration and Opening

—————————— **Session A** —————————— Chair: Jaehoon Kim

14:00 - 14:40	**Jineon Baek**. *Optimality of Gerver's Sofa*
14:50 - 15:30	**Young-Hun Kim**. *Quasisymmetric functions and categories of modules of the 0-Hecke algebras*
15:30 - 16:00	Coffee break

—————————— **Session B** —————————— Chair: Seunghyun Seo

16:00 - 16:40	**Meesue Yoo**. *(Awe)some techniques to deal with plethystic substitution*
16:50 - 17:30	**Ander Lamaison**. *Palettes determine uniform Turán density*
18:00 -	Dinner

2nd Day: February 21 (Friday)

—————————— **Session C** —————————— Chair: Jang Soo Kim

09:30 - 10:30	Breakfast
10:30 - 11:10	**Byung-Hak Hwang**. *Noncommutative symmetric functions and skewing operators*
11:20 - 12:00	**Eng Keat Hng**. *Graphon branching processes and fractional isomorphism*
12:00 - 14:00	Lunch

—————————— **Session D** —————————— Chair: Seog-Jin Kim

14:00 - 14:40	**Sunyo Moon**. *A characterization of signed graphs with Laplacian spectral integral variation*
14:50 - 15:30	**Cheolwon Heo**. *Recent Progress on the Complexity of Matroid Homomorphism Problems*
15:30	Closing

Speaker: Jineon Baek

Affiliation: Yonsei University

Title: Optimality of Gerver's Sofa

Abstract

We resolve the *moving sofa problem*, posed by Moser in 1966, which asks for the maximum area of a connected planar shape that can move around the right-angled corner of a *L*-shaped hallway with unit width. We confirm the conjecture made by Gerver in 1994 that his construction, known as *Gerver's sofa*, with 18 curve sections attains the maximum area $2.2195\ldots$.

Speaker: Cheolwon Heo

Affiliation: SUNY Korea

Title: Recent Progress on the Complexity of Matroid Homomorphism Problems

Abstract

We introduce homomorphisms between binary matroids that generalize graph homomorphisms. The complexity of graph homomorphism problems has been widely studied, leading to significant insights and classification results. In this talk, we extend these results to the setting of matroid homomorphisms, introducing a framework that generalizes graph homomorphism concepts to binary matroids.

For a binary matroid N, we prove that the problem of deciding if a given binary matroid admits a homomorphism to N is polynomial-time solvable if N has a loop or has no circuits of odd length, and is NP-complete otherwise. We also get dichotomy theorems for the list, extension, and retraction versions of the problem. Furthermore, we investigate reconfiguration problems for matroid homomorphisms. Given two homomorphisms ϕ_1 and ϕ_2 from a binary matroid M to N, we determine whether there exists a sequence of homomorphisms connecting them, where each pair of consecutive homomorphisms differs on a cocircuit of N. We show that this problem is trivial when N is isomorphic to the graphic matroid $M(K_2)$, and PSPACE-Complete when N is isomorphic to $M(K_t)$ for $t \geq 3$.

Speaker: Eng Keat Hng

Affiliation: IBS ECORPO

Title: Graphon branching processes and fractional isomorphism

Abstract

In 2005, Bollobás, Janson and Riordan introduced and extensively studied a general model of inhomogeneous random graphs parametrised by graphons. In particular, they studied the emergence of a giant component in these inhomogeneous random graphs by relating them to a broad collection of inhomogeneous Galton-Watson branching processes.

Fractional isomorphism of finite graphs is an important and well-studied concept at the intersection of graph theory and combinatorial optimisation. It has many different characterisations that involve a range of very different and seemingly unrelated properties of graphs. Recently, Grebík and Rocha developed a theory of fractional isomorphism for graphons.

In this talk, we discuss the characterisation of inhomogeneous random graphs that yield the same inhomogeneous Galton-Watson branching process (and hence have a similar component structure) using the theory of fractional isomorphism.

This is based on joint work with Jan Hladký and Anna M. Limbach.

Speaker: Byung-Hak Hwang

Affiliation: KIAS

Title: Noncommutative symmetric functions and skewing operators

Abstract

The expansion of a symmetric function into specific bases often uncovers algebraic, geometric, or probabilistic insights. As a result, finding combinatorial interpretations for the coefficients becomes a central problem in algebraic combinatorics. Noncommutative symmetric function theory serves as a powerful tool to address this challenge. In this talk, I will introduce the theory of noncommutative symmetric functions and demonstrate how it can be extended to explore the multiplicative structure of symmetric functions.

Speaker: Young-Hun Kim

Affiliation: SNU, QSMS

Title: Quasisymmetric functions and categories of modules of the 0-Hecke algebras

Abstract

   The 0-Hecke algebra is a deformation of the group algebra of the symmetric group. Just as the category of modules of symmetric groups categorifies the ring of symmetric functions, the category of modules of 0-Hecke algebras categorifies the ring of quasisymmetric functions. Based on this fact, various 0-Hecke modules have been constructed to provide representation-theoretic interpretations of important quasisymmetric functions. Recently, to develop a unified framework for studying these modules, we introduced weak Bruhat interval modules (WBIMs), rediscovered the poset modules, and recovered various 0-Hecke modules as WBIMs and poset modules. Furthermore, we proved that the Grothendieck rings of the categories of direct sums of WBIMs and poset modules are both isomorphic to the ring of quasisymmetric functions. In this talk, we will discuss the definitions and structures of these categories.

Speaker: Ander Lamaison

Affiliation: IBS ECOPRO

Title: Palettes determine uniform Turán density

Abstract

We study Turán problems for hypergraphs with an additional uniformity condition on the edge distribution. This kind of Turán problems was introduced by Erdős and Sós in the 1980s but it took more than 30 years until the first non-trivial exact results were obtained. Central to the study of the uniform Turán density of hypergraphs are palette constructions, which were implicitly introduced by Rödl in the 1980s. We prove that palette constructions always yield tight lower bounds, unconditionally confirming present empirical evidence. This results in new and simpler approaches to determining uniform Turán densities, which completely bypass the use of the hypergraph regularity method.

Speaker: Sunyo Moon

Affiliation: KIAS

Title: A characterization of signed graphs with Laplacian spectral integral variation

Abstract

Spectral variation of two matrices is integral if their spectra differ by integer quantities. For two signed graphs, where one is obtained from the other by adding a new edge, we characterize when the spectral variation of their signed Laplacian matrices becomes integral. Furthermore, for every fixed signed complete graph, we fully characterize the class of signed graphs to which one can recursively add new edges keeping spectral integral variation to make the signed complete graph. This is joint work with Jungho Ahn and Cheolwon Heo.

Speaker: Meesue Yoo

Affiliation: CBNU

Title: (Awe)some techniques to deal with plethystic substitution

Abstract

In the paper introducing alpha-chromatic symmetric functions (arxiv: 2407.06965), we applied two machineries to deal with the plethystic substitution in the definition of the alpha-chromatic symmetric functions, one is the superization technique and the other is the XY-technique. In this talk, I'll go over these two techniques with some details. This result is based on joint work with Jim Haglund and Jaeseong Oh.

3   List of Participants

1. Ahn, Jungho (KIAS)

2. Baek, Jineon (Yonsei University)

3. Chae, Jihyo (Yonsei University)

4. Chang, Yeonsu (Hanyang University)

5. Cho, Minho (IBS ECOPRO)

6. Cho, Eun-Kyung (Hanyang University)

7. CHOI, ILKYOO (Hankuk University of Foreign Studies)

8. Choi, Mujin (KAIST & IBS DIMAG)

9. Chu, Hojin (Seoul National University)

10. Eom, Taehyun (Chonnam National University)

11. Heo, Cheolwon (SUNY Korea)

12. Hng, Eng Keat (IBS ECOPRO)

13. Huh, JiSun (Ajou University)

14. Hwang, Byung-Hak (KIAS)

15. Kim, Gunwoo (KAIST/ IBS DIMAG)

16. Kim, Hyobeen (Kyungpook National University)

17. Kim, Jaehoon (KAIST)

18. Kim, Jang Soo (Sungkyunkwan University)

19. Kim, Jeong Han (KIAS)

20. Kim, Seog-Jin (Konkuk University)

21. Kim, Seokbeom (KAIST & IBS DIMAG)

22. Kim, Young-Hun (SNU QSMS)

23. Kwon, Hyemin (KIAS)

24. Lamaison, Ander (Institute for Basic Science)

25. Lee, Hojoon (Sungkyunkwan University)

26. Lee, Hyoyoon (Sogang University)

27. Lee, Sang June (Kyung Hee University)

28. Lee, Seunghun (KAIST)

29. Moon, Sunyo (KIAS)

30. Oh, Jaeseong (KIAS HCMC)

31. Oum, Sang-il (IBS DIMAG)

32. Park, Hyemi (Hanyang university)

33. Park, Jeong Rye (Kyungpook National University)

34. Park, Jihye (Yeungnam University)

35. Park, Jongyook (Kyungpook National University)

36. Park, Kiyun (KAIST)

37. Park, Youngwoo (KAIST)

38. Seo, Jaehyeon (Yonsei University)

39. Seo, Seunghyun (Kangwon National University)

40. Seong, Ian (University of Wisconsin-Madison)

41. Shin, Heesung (Inha University)

42. Song, Minho (Sungkyunkwan University)

43. SONG, SEOK-ZUN (Jeju National University)

44. Xi, Changqing (Hanyang University)

45. Yoo, Meesue (CBNU)

46. Yoo, Semin (IBS DIMAG)