Vietnam Mathematical Society

Korean Mathematical Society

ABSTRACT BOOK

THE 3RD VIETNAM - KOREA JOINT WORKSHOP ON SELECTED TOPICS IN MATHEMATICS

JANUARY 6-9, 2025

Institute of Mathematics
Vietnam Academy of Science and Technology
Hanoi, Vietnam

THE THIRD VIETNAM - KOREA WORKSHOP
ON SELECTED TOPICS IN MATHEMATICS

Hanoi, January 6-9, 2025

PROGRAM
&
ABSTRACTS

THE THIRD VIETNAM - KOREA WORKSHOP ON SELECTED TOPICS IN MATHEMATICS

Hanoi, January 6-9, 2025

ORGANIZING INSTITUTIONS

- Vietnam Mathematical Society
- Korean Mathematical Society
- Institute of Mathematics, Vietnam Academy of Science and Technology

ORGANIZING COMMITTEE

Sijong Kwak (Korea Advanced Institute of Science and Technology, Korea), Vu Hoang Linh (VNU University of Science, Hanoi, Vietnam), Jongil Park (Seoul National University, Korea), Doan Thai Son (Institute of Mathematics, VAST, Vietnam).

PROGRAM COMMITTEE

Jaeyoung Byeon (Korea Advanced Institute of Science and Technology, Korea), Doan Trung Cuong (Institute of Mathematics, VAST, Vietnam).

SESSION ORGANIZERS

Session A: Algebra, Geometry and Topology

Yunhyung Cho (Sungkyunkwan University, Korea), Nguyen Thac Dung (VNU University of Science, Hanoi, Vietnam), Le Tuan Hoa (Institute of Mathematics, VAST, Vietnam), Wanseok Lee (Pukyung National University, Korea), Jinhyung Park (Korea Advanced Institute of Science and Technology, Korea), Do Duc Thai (Hanoi National University of Education, Vietnam).

Session C: Combinatorics and Discrete Mathematics

Phan Thi Ha Duong (Institute of Mathematics, VAST, Vietnam), Jang Soo Kim (Sungkyunkwan University, Korea), Seog-Jin Kim (Konkuk University, Korea), Doowon Koh (Chungbuk National University, Korea), Pham Van Thang (VNU University of Science, Hanoi, Vietnam), Le Anh Vinh (Vietnam Institute of Educational Sciences, Vietnam).

Session D: Differential Equations and Dynamical Systems

Cung The Anh (Hanoi National University of Education, Vietnam), Hyeong-Ohk Bae (Ajou University, Korea), Nguyen Huu Du (VNU University of Science, Hanoi, Vietnam), Seung-Yeal Ha (Seoul National University, Korea), Doan Thai Son

(Institute of Mathematics, VAST, Vietnam), Younghwan Son (Pohang University of Science and Technology, Korea).

Session O: Optimization and Data Science

Ho Tu Bao (Vietnam Institute for Advanced Study in Mathematics, Vietnam), Hyung Ju Hwang (Pohang University of Science and Technology, Korea), Do Sang Kim (Pukyong National University, Korea), Yongdo Lim (Sungkyunkwan University, Korea), Le Hong Phuong (VNU University of Science, Hanoi, Vietnam), Nguyen Dong Yen (Institute of Mathematics, VAST, Vietnam).

SPONSORS

- Vietnam Mathematical Society (VMS)
- Korean Mathematical Society (KMS)
- International Centre of Research and Postgraduate Training in Mathematics under the auspices of UNESCO (ICRTM)
- Korea Institute for Advanced Study (KIAS)

CONTENT

PROGRAM

Code

P: Plenary talks
A: Algebra, Geometry and Topology
C: Combinatorics and Discrete Mathematics
D: Differential Equations and Dynamical Systems
O: Optimization and Data Science

Monday, January 6, 2025

Morning

08:30 – 09:00 Registration (Hoang Tuy Conference Hall, Building A6)

09:00 – 09:30 Opening Ceremony and Group Photo (Hoang Tuy Conference Hall, Building A6)

09:30 – 09:40 Break

09:40 – 10:30: Plenary talk
Chair: Yunhyung Cho (Sungkyunkwan University, Korea)
P1: **Cheol-Hyun Cho** (Seoul National University, Korea)
On the mirror symmetry of invertible polynomials page 25

10:30 – 10:50 Break
10:50 – 11:40: Plenary talk
Chair: Vu Hoang Linh (VNU University of Science, Hanoi, Vietnam)
P2: **Dinh Nho Hao** (Institute of Mathematics, VAST, Vietnam)
Learning water quality models page 25

Afternoon

Time	**A/Room 612**	**C/Room 508**	**D/Room 301**	**O/ Conference Hall**
13:30-14:10	(A1) B.H. An	(C1) J.S. Kim	H.O. Bae (D1)	(O1) J. Shin
14:10-14:15	Break			
14:15-14:55	(A2) N.T. Hoang	(C2) P.V. Thang	(D2) N.Q. Anh	(O2) Y. Kim
14:55-15:15	Break			
15:15-15:55	(A3) J. Oh	(C3) J. Park	(D3) Y.P. Choi	(O3) H. Son
15:55-16:00	Break			
16:00-16:40	(A4) D.V. Cuong	(C4) D.T. Hoang	(D4) J. Yoo	(O4) N.V. Tuyen
16:40-16:50	Break			
16:50-17:30	(A5) J. Won	(C5) P.M. Hanh	(D5) S. Hong (D6) M.S. Lee	(O5) N.H. Chieu

Tuesday, January 7, 2025

Morning

09:00 – 09:50: Plenary talk
Chair: Nguyen Dinh (International University, VNU-HCMC, Vietnam)
P3: **Pham Tien Son** (Dalat University, Vietnam)
An invitation to semi-algebraic optimization page 26

09:50 – 10:05 Break
10:05 – 10:55: Plenary talk
Chair: Seog-Jin Kim (Konkuk University, Korea)
P4: **Jeong Han Kim** (Korea Institute for Advanced Study, Korea)
Survey on asymptotic bounds for Ramsey numbers page 26

10:55 – 11:10 Break
11:10 – 12:00: Plenary talk
Chair: Ngo Viet Trung (Institute of Mathematics, VAST, Vietnam)
P5: **Pham Hung Quy** (FPT University, Hanoi, Vietnam)
A study of rings of positive characteristic page 27

Afternoon

Time	**A/Room 612**	**C/Room 508**	**D/Room 301**	**O/ Conference Hall**
13:30-14:10	(A6) J.H. Park	(C6) N.T. Hieu	(D7) D.A. Tuan	(O6) N. Dinh
14:10-14:15	Break			
14:15-14:55	(A7) D.N. Son	(C7) H.A. Duc	(D8) J.Y. Lee	(O7) H.N. Tuan
14:55-15:15	Break			
15:15-15:55	(A8) M. Kim	(C8) S. Bang	(D9) D.D. Thuan	(O8) V.T. Huong
15:55-16:00	Break			
16:00-16:40	(A9) T.G. Nam	(C9) M. Kim	(D10) S. Kwon	(O9) S. Ko
16:40-16:50	Break			
16:50-17:30	(A10) I.K. Kim	(C10) D.D. Hieu	(D11) P.T. Huong (D12) T.V. Tuan	(O10) S. Lee

Wednesday, January 8, 2025

Morning

09:00 – 09:50: Plenary talk
Chair: Hyeong-Ohk Bae (Ajou University, Korea)
P6: **Namkwon Kim** (Chosun University, Korea)
Solution spaces of static Chern-Simons systems in the whole space page 27

09:50 – 10:05 Break
10:05 – 10:55: Plenary talk
Chair: Pham Van Thang (VNU University of Science, Hanoi, Vietnam)
P7: **Tran Manh Tuan** (University of Science and Technology of China, China)
Approximate packing of transversals in locally sparse graphs page 27

10:55 – 11:10 Break
11:10 – 12:00: Plenary talk
Chair: Yongdo Lim (Sungkyunkwan University, Korea)
P8 **Woocheol Choi** (Sungkyunkwan University, Korea)
New convergence results on the primal type algorithms for the distributed optimization page 28

Afternoon **Free discussion**

18:00: Banquet

Thursday, January 9, 2025

Morning

Time	A/Room 612	C/Room 508	D/Room 301	O/ Conference Hall
09:00-09:40	(A11) S.H. Kim	(C11) J. Lee	(D13) Y. Cho	(O11) L.S. Vinh
09:40-09:45	Break			
09:45-10:25	(A12) N.V. Thu	(C12) M. Yoo	(D14) C.V. Hao	(O12) P.H. Tung
10:25-10:40	Break			
10:40-11:20	(A13) K. Chung	(C13) C. Heo	(D15) H. Lee	(O13) H. Choi
11:20-11:25	Break			
11:25-12:05			(D16) N.T. Hoai	(O14) G.M. Cho

Afternoon

Time	A/Room 612	C/Room 508	D/Room 301	O/ Conference Hall
13:30-14:10	(A14) S.D. Quang		(D17) T.D. Ke	(O15) J. Jeong
14:10-14:15	Break			
14:15-14:55	(A15) H. Yoo		(D18) T.M. Phuong	(O16) G.M. Lee
14:55-15:15	Break			
15:15-15:55	(A16) N.Q. Thang		(O15) D. Kim	(O17) N.T. Thanh
15:55-16:00	Break			
16:00-16:40			(D20) P.T. Duong	(O18) L.H. Phuong
16:40-16:50	Break			
16:50-17:30				(O19) T.T. Hung

A: Algebra, Geometry and Topology

Room 612, Building A6

Monday, January 6, 2025

Afternoon

Chair: Le Minh Ha (Vietnam Institute of Advanced Study in Mathematics)

13:30 – 14:10 Byung Hee An (Kyungpook National University, Korea)
A1 *Betti number growth polynomials of braid groups on graphs with circumference* 1

14:10 – 14:15 Break

14:15 – 14:55 Nguyen Thanh Hoang (FPT Univesity, Da Nang, Vietnam)
A2 *Quasi-redirecting boundaries of non-positively curved groups*

14:55 – 15:15 Break

Chair: Kiryong Chung (Kyungpook National University, Korea)

15:15 – 15:55 Jeongseok Oh (Seoul National University, Korea)
A3 *The quantum Lefschetz principle*

15:55 – 16:00 Break

16:00 – 16:40 Do Viet Cuong (Hanoi University of Sciences, VNU, Vietnam)
A4 *On the Higgs bundles and the Hitchin fibrations*

16:40 – 16:50 Break

16:50 – 17:30 Jooneyong Won (Ewha Womans University, Korea)
A5 *On singular del Pezzo surfaces embedded in weighted projective spaces*

Tuesday, January 7, 2025

Afternoon

Chair: Joonyeong Won (Ewha Womans University, Korea)

13:30 – 14:10 JungHwan Park (Korea Advanced Institute of Science and Technology, Korea)
A6 *Obstructions to sliceness via equivariant theory*

14:10 – 14:15 Break

14:15 – 14:55 Duong Ngoc Son (Phenikaa University, Vietnam)
A7 *On CR maps of hyperquadrics and Winkelmann hypersurfaces with vanishing geometric rank*

14:55 – 15:15 Break

Chair: Phung Ho Hai (Institute of Mathematics, VAST, Vietnam)

15:15 – 15:55 Myungho Kim (Kyung Hee University, Korea)
A8 *Cluster algebras and monoidal categories*

15:55 – 16:00 Break

16:00 – 16:40 Tran Giang Nam (Institute of Mathematics, VAST, Vietnam)
A9 *Williams' Conjecture holds for graphs of Gelfand-Kirillov dimension 3*

16:40 – 16:50 Break

16:50 – 17:30 In-Kyun Kim (Korea Institute for Advanced Study, Korea)
A10 *K-stability of blow-ups of the weighted projective planes*

Thursday, January 9, 2025

Morning

Chair: Do Duc Thai (Hanoi National University of Education, Vietnam)

09:00 – 09:40 Sang-Hyun Kim (Korea Institute for Advanced Study, Korea)
A11 *First order rigidity of manifold homeomorphism groups*

09:40 – 09:50 Break

09:50 – 10:30 Ninh Van Thu (Hanoi University of Sciences and Technology, Vietnam)
A12 *Pinchuk scaling method and characterization of pseudoconvex domains in* $\mathbb{C}^n$

10:30 – 10:40 Break

10:40 – 11:20 Kiryong Chung (Kyungpook National University, Korea)
A13 *Rational curves in the Mukai-Umemura variety*

Afternoon

Chair: Jinhyung Park (Korea Advanced Institute of Science and Technology, Korea)

13:30 – 14:10 Si Duc Quang (Hanoi National University of Education, Vietnam)
A14 *Modified defect relation for Gauss maps of minimal surfaces with hypersurfaces of projective varieties in subgeneral position and related problems*

14:10 – 14:15 Break

14:15 – 14:55 Hwajong Yoo (Seoul National University, Korea)
A15 *The rational torsion subgroups of modular Jacobian varieties*

14:55 – 15:15 Break

15:15 – 15:55 Nguyen Quoc Thang (Institute of Mathematics, VAST, Vietnam)
A16 *Some local-global principles and applications*

C: Combinatorics and Discrete Mathematics

Room 508, Building A6

Monday, January 6, 2025

Afternoon

Chair: Doowon Koh (Chungbuk National University, Korea)

13:30 – 14:10 Jang Soo Kim (Sungkyunkwan University, Korea)
C1 *Enumeration of multiplex juggling card sequences using generalized q-derivatives*

14:10 – 14:15 Break

14:15 – 14:55 Pham Van Thang (VNU University of Science, Hanoi, Vietnam)
C2 *Polynomial images: discrete and continuous*

14:55 – 15:15 Break

Chair: Pham Van Thang (VNU University of Science, Hanoi, Vietnam)

15:15 – 15:55 Jongyook Park (Kyungpook National University, Korea)
C3 *Ruling out two infinite families of putative strongly regular graphs using generalized methods*

15:55 – 16:00 Break

16:00 – 16:40 Do Trong Hoang (Hanoi University of Science and Technology, Vietnam)
C4 *On the number of k-independent sets of $\mathbf{W}_p$ graphs*

16:40 – 16:50 Break

16:50 – 17:10 Pham My Hanh (Hanoi University of Science and Technology, Vietnam)
C5 *Unimodality of the independence polynomial of $G \circ (K_p \cup K_q)$*

Tuesday, January 7, 2025

Afternoon

Chair: Phan Thi Ha Duong (Institute of Mathematics, VAST, Vietnam)

13:30 – 14:10 Ngo Trung Hieu (Institute of Mathematics, VAST, Vietnam)
C6 *A matrix variant of the Erdős-Falconer distance problems over finite field*

14:10 – 14:15 Break

14:15 – 14:55 Hoang Anh Duc (VNU University of Science, Hanoi, Vietnam)
C7 *The complexity of some reconfiguration problems on graphs with distance constraints*

14:55 – 15:15 Break

Chair: Doowon Koh (Chungbuk National University, Korea)

15:15 – 15:55 Sejeong Bang (Yeungnam University, Korea)
C8 *Geometric distance-regular graphs*

15:55 – 16:00 Break

16:00 – 16:40 Minki Kim (Gwangju Institute of Science and Technology, Korea)
C9 *A new variant of Tverberg theorem*

16:40 – 16:50 Break

16:50 – 17:10 Do Duy Hieu (Institute of Mathematics, VAST, Vietnam)
C10 *Community detection in directed graphs using stationary distribution and hitting times methods*

Thursday, January 9, 2025

Morning

Chair: Jang Soo Kim (Sungkyunkwan University, Korea)

09:00 – 09:40 Joonkyung Lee (Yonsei University, Korea)
C11 *Counting homomorphisms in antiferromagnetic graphs via Lorentzian polynomials*

09:40 – 09:45 Break

09:45 – 10:25 Meesue Yoo (Chungbuk National University, Korea)
C12 *α-chromatic symmetric functions*

10:25 – 10:40 Break

10:40 – 11:20 Cheolwon Heo (Korea Institute for Advanced Study, Korea)
C13 *The complexity of matroid homomorphism reconfiguration*

D: Differential Equations and Dynamical Systems

Room 301 Building A5

Monday, January 6, 2025

Afternoon

Chair: Seung-Yeal Ha (Seoul National University, Korea)

13:30 – 14:10 Hyeong-Ohk Bae (Ajou University, Korea)
D1 *Serrin-type Condition to Shear Thickening non-Newtonian Fluid*

14:10 – 14:15 Break

14:15 – 14:55 Ngo Quoc Anh (VNU University of Science, Hanoi, Vietnam)
D2 *Sobolev inequalities on the standard sphere: old and new*

14:55 – 15:15 Break

Chair: Hoang The Tuan (Institute of Mathematics, VAST, Vietnam)

15:15 – 15:55 Young-Pil Choi (Yonsei University, Korea)
D3 *Critical thresholds in pressureless Euler–Poisson equations with background states*

15:55 – 16:00 Break

16:00 – 16:40 Jane Yoo (Ajou University, Korea)
D4 *Mathematical modeling of multi-fashion trend: flocking and differentiation*

16:40 – 16:50 Break

Chair: Tran Dinh Ke (Hanoi National University of Education, Vietnam)

16:50 – 17:30 Soonki Hong (Pohang University of Science and Technology, Korea)
D5 *Local limit theorem of the Brownian motion on simplicial trees*

Myeong-Su Lee (Korea Advanced Institute of Science and Technology, Korea)
D6 *Physics-informed Neural Networks for the Pseudo-two-dimensional model of Lithium ion battery*

Tuesday, January 7, 2025

Afternoon

Chair: Doan Thai Son (Institute of Mathematics, VAST, Vietnam)

13:30 – 14:10 Duong Anh Tuan (Hanoi University of Science and Technology, Vietnam)
D7 *Non-existence results of positive solutions for a system of elliptic inequalities on weighted graphs*

14:10 – 14:15 Break

14:15 – 14:55 Jeong-Yup Lee (Catholic Kwandong University, Korea)
D8 *Finding minimal modules for substitution tilings*

14:55 – 15:15 Break

Chair: Jeong-Yup Lee (Catholic Kwandong University, Korea)

15:15 – 15:55 Do Duc Thuan (Hanoi University of Science and Technology, Vietnam)
D9 *Solvability and stability of stochastic singular systems*

15:55 – 16:00 Break

16:00 – 16:40 Sanghoon Kwon (Catholic Kwandong University, Korea)
D10 *Dynamical zeta function of non-compact high-dimensional weighted complexes*

16:40 – 16:50 Break

Chair: Do Duc Thuan (Hanoi University of Science and Technology, Vietnam)

16:50 – 17:30 Phan Thi Huong (Le Quy Don Technical University, Vietnam)
D11 *The θ-scheme for Caputo fractional differential equations*

Tran Van Tuan (Hanoi Pedagogical University 2, Vietnam)
D12 *Regularity in time of solutions for semilinear fractional reaction–subdiffusion equations in bounded domains*

Thursday, January 9, 2025

Morning

Chair: Hyeong-Ohk Bae (Ajou University, Korea)

09:00 – 09:40 Yonggeun Cho (Jeonbuk National University, Korea)
D13 *Nonlinear scattering of 3D Maxwell-Dirac equation*

09:40 – 09:45 Break

09:45 – 10:25 Can Van Hao (Institute of Mathematics, VAST, Vietnam)
D14 *Fluctuation of chemical distance in Bernoulli percolation*

10:25 – 10:40 Break

Chair: Can Van Hao (Institute of Mathematics, VAST, Vietnam)

10:40 – 11:20 Ho Lee (Kyung Hee University, Korea)
D15 *Spatially homogeneous solutions to the Einstein-Boltzmann system with soft potentials*

11:20 – 11:25 Break

11:25 – 12:05 Nguyen Thi Hoai (VNU University of Science, Hanoi, Vietnam)
D16 *Projector approach for constructing asymptotic solution of singularly perturbed discrete-time weakly optimal control problem in the critical case*

Thursday, January 9, 2025

Afternoon

Chair: Cung The Anh (Hanoi National University of Education, Vietnam)

13:30 – 14:10 Tran Dinh Ke (Hanoi National University of Education, Vietnam)
D17 *On a class of subdiffusion equations in the whole space*

14:10 – 14:15 Break

14:15 – 14:55 Tran Minh Phuong (Ton Duc Thang University, HCM City, Vietnam)
D18 *Gradient regularity for nonlinear elliptic equations involving fractional maximal operators*

14:55 – 15:15 Break

Chair: Younghwan Son (Pohang University of Science and Technology, Korea)

15:15 – 15:55 Doheon Kim (Hanyang University, Korea)
D19 *Analytical theory of score-based diffusion models with multiplicative noise conditioning*

15:55 – 16:00 Break

16:00 – 16:40 Pham Trieu Duong (Hanoi National University of Education, Vietnam)
D20 *Decay character and semilinear structurally damped σ-evolution equations with time-dependent damping*

O: Optimization and Data Science

Hoang Tuy Conference Hall, Building A6

Monday, January 6, 2025

Afternoon

Chair: Hyung Ju Hwang (Pohang Unviersity of Science and Technology, Korea)

13:30 – 14:10 Jaemin Shin (Chungbuk National Univertiy, Korea)
O1 *Exploring Turing Pattern Classification through Convolutional Neural Networks and Feature Engineering*

14:10 – 14:15 Break

Chair: Yongdo Lim (Sungkyunkwan University, Korea)

14:15 – 14:55 Yeoneung Kim (Seoul National University of Science and Education, Korea)
O2 *Hamilton–Jacobi Based Policy-Iteration via Deep Operator Learning*

14:55 – 15:15 Break

Chair: Jaemin Shin (Chungbuk National Univertiy, Korea)

15:15 – 15:55 Hwijae Son (Konkuk University, Korea)
O3 *A PINN approach for identifying governing parameters of noisy thermoacoustic systems*

15:55 – 16:00 Break

Chair: Pham Tien Son (Dalat University, Vietnam)

16:00 – 16:40 Nguyen Van Tuyen (Hanoi Pedagogical University 2, Vietnam)
O4 *Existence and stability of solutions for nonconvex optimization problems via asymptotic analysis*

16:40 – 16:50 Break

Chair: Gue Myung Lee (Pukyong National University, Korea)

16:50 – 17:30 Nguyen Huy Chieu (Vinh University, Vietnam)
O5 *Tilt stability for nonlinear programs*

Tuesday, January 7, 2025

Afternoon

Chair: Nguyen Dong Yen (Institute of Mathematics, VAST, Vietnam)

13:30 – 14:10 Nguyen Dinh (International University, VNU-HCMC, Vietnam)
O6 *Characterizations of Farkas-type results involving linear-convex/concave systems with applications and generalization*

14:10 – 14:15 Break

Chair: Nguyen Nang Tam (Duy Tan University, Hanoi, Vietnam)

14:15 – 14:55 Hoang Ngoc Tuan (Hanoi Pedagogical University 2, Vietnam)
O7 *Error bounds for a class of cone-convex inclusion problems*

14:55 – 15:15 Break

Chair: Dao Ngoc Minh (RMIT University, Australia)

15:15 – 15:55 Vu Thi Huong (Institute of Mathematics, VAST, Vietnam and Zuse Institute Berlin, Germany)
O8 *Google pagerank and citation networks through the optimization lens*

15:55 – 16:00 Break

Chair: Yeoneung Kim (Seoul National University of Science and Education, Korea)

16:00 – 16:40 Seungchan Ko (Inha University, Korea)
O9 *Mathematical Theory of Neural Network Approximation and its Application to Scientific Machine Learning*

16:40 – 16:50 Break

Chair: Hyung Ju Hwang (Pohang Unviersity of Science and Technology, Korea)

16:50 – 17:30 Seunggyu Lee (Korea University, Korea)
O10 *Gradient flow and its numerical methods*

Thursday, January 9, 2025

Morning

Chair: Ho Tu Bao (Vietnam Institute of Advanced Study in Mathematics, Vietnam)

09:00 – 09:40 Le Si Vinh (University of Engineering and Technology, VNU, Vietnam)
O11 *From few sequences to whole genomes: the next challenges in evolutionary studies*

09:40 – 09:45 Break

Chair: Le Hong Phuong (VNU University of Science, Hanoi, Vietnam)

09:45 – 10:25 Pham Huy Tung (VinAI, Vietnam)
O12 *On barycenter computation: semi-unbalanced optimal transport-based method on Gaussians*

10:25 – 10:40 Break

Chair: Seunggyu Lee (Korea University, Korea)

10:40 – 11:20 Hayoung Choi (Kyungpook National University, Korea)
O13 *Solving group-sparse problems via deep neural networks with theoretical guarantee*

11:20 – 11:25 Break

Chair: Gue Myung Lee (Pukyong National University, Korea)

11:25 – 12:05 Gyeong-Mi Cho (Dongseo University, Korea)
O14 *New interior-point methods for linear optimization problems*

Thursday, January 9, 2025

Afternoon

Chair: Hayoung Choi (Kyungpook National University, Korea)

13:30 – 14:10 Juyoung Jeong (Changwon National University, Korea)
O15 *Commutation principles for nonsmooth variational problems on Euclidean Jordan algebras*

14:10 – 14:15 Break

Chair: Do Sang Kim (Pukyong National University, Korea)

14:15 – 14:55 Gue Myung Lee (Pukyong National University, Korea)
O16 *On Solving Fractional SOS Convex Polynomial Optimization Problem*

14:55 – 15:15 Break

Chair: Le Si Vinh (University of Engineering and Technology, VNU, Vietnam)

15:15 – 15:55 Nguyen Trung Thanh (National Economics University, Vietnam)
O17 *On the nonnegative rank factorization and the completely positive factorization*

15:55 – 16:00 Break

Chair: Ho Tu Bao (Vietnam Institute of Advanced Study in Mathematics, Vietnam)

16:00 – 16:40 Le Hong Phuong (VNU University of Science, Hanoi, Vietnam)
O18 *A cost-efcient and high-performance framework for diagnosing papillary thyroid carcinoma*

16:40 – 16:50 Break

Chair: Le Hong Phuong (VNU University of Science, Hanoi, Vietnam)

16:50 – 17:30 Tran The Hung (Hanoi University of Science and Technology, Vietnam)
O19 *Recent advances of bayesian optimization*

ABSTRACTS

P: Plenary talks

P1: On the mirror symmetry of invertible polynomials

Cheol-Hyun Cho

Seoul National University, Korea

Berglund-Hübsch mirror symmetry is a duality between two invertible polynomials and their symmetry groups. In particular, in the case of curve singularities, geometric curves in the Milnor fiber of one singularity are related to the matrix factorizations of its transpose polynomial. We propose a geometric method to construct the mirror polynomial via Floer theory, and a canonical functor that transforms curves to matrix factorizations for curve singularities. This is a joint work with Choa and Jeong.

P2: Learning water quality models

Dinh Nho Hao

Institute of Mathematics, VAST, Vietnam

Dissolved oxygen (DO) and biochemical oxygen demand (BOD) are among the most important water quality indicating factors. The advection-reaction (AR) equations or advection-diffusion-reaction (ADR) equations are used as a water quality model which describes the evolution of BOD and DO in a river or stream. In these models, the coefficients representing the deoxygenation and reaeration rates are not known, and there are some empirical formulas for the reaeration rate, but none for the deoxygenation one. Furthermore, it is difficult to confirm the validity of these formulas for an arbitrary river stretch because this coefficient depends on geological factors of the river.

In this talk, we consider the inverse problem of determining these coefficients from additional measurements (learning water quality models).

First, based on available data, we use sparse regularization techniques to determining some water quality models. Second, based on the Carleman estimates technique, we prove Lipschitz-type stability estimates for DO-BOD models with respect to data. For numerical computation, the coefficient identification problem is reformulated as an optimization problem using the least-squares method coupled with the adjoint equation method for computing the gradient of the objective functional. Error estimates are derived and numerical examples are provided for demonstrating the

performance of the proposed algorithm.

In collaboration with Nguyen Trung Thanh, Nguyen Van Duc, and Nguyen Van Thang.)

P3: An invitation to semi-algebraic optimization

Pham Tien Son

Dalat University, Vietnam

A semi-algebraic set is a subset of $\mathbf{R}^n$ defined by a finite sequence of polynomial equations (of the form $f(x) = 0$) and inequalities (of the form $g(x) > 0$), or any finite union of such sets; a semi-algebraic mapping is a mapping with a semi-algebraic graph. Semi-algebraic sets and mappings have distinctive and recognizable structural properties which make them an attractive domain for various applications. In this talk we survey some recent results on semi-algebraic optimization.

P4: Survey on asymptotic bounds for Ramsey Numbers

Jeong Han Kim

Korea Institute for Advanced Study, Korea

Ramsey numbers are a cornerstone of combinatorial mathematics, representing the minimum size of a structure required to guarantee a certain property. Specifically, the classical Ramsey number is the smallest integer such that any red-blue edge-coloring of the complete graph contains a monochromatic red clique or a monochromatic blue clique of certain sizes. Despite their simplicity in definition, Ramsey numbers are notoriously difficult to compute or even estimate, leading to a wealth of research on asymptotic bounds. In this talk, we focus on asymptotic bounds for Ramsey Numbers $R(3,t)$ and $R(4,t)$ including a recent bound of Sam Mattheus and Jacques Verstraete for $R(4,t)$.

P5: A study of rings of positive characteristic

Pham Hung Quy

FPT University, Hanoi, Vietnam

The study of rings with positive characteristic has been a rich area in commutative algebra, particularly focusing on F-singularities, which leverage the Frobenius endomorphism unique to rings of characteristic $p > 0$. Three specific types of F-singularities are under investigation: (1) F-injectivity, (2) F-nilpotency, and (3) tight Buchsbaum singularities. This based on joint works with Kazuma Shimomoto (2017), Thomas Polstra (2019) and Linquan Ma (2022).

P6: Solution spaces of static Chern-Simons systems in the whole space

Namkwon Kim

Chosun University, Korea

Static PDEs arising in the area of Chern-Simons gauge theories are closely related with other areas in mathematics such as prescribed curvature problems, mean field theory, and biological systems. We present here recent progress on the existence of solutions and the structure of the solution spaces of such Chern-Simons systems. Depending on the gauge group of the system, the structure of the solution space gets changed drastically. We mainly analyse bubbling solutions and the (Leray-Schauder) degree of the system to approach the problem.

P7: Approximate packing of transversals in locally sparse graphs

Tran Manh Tuan

University of Science and Technology of China, China

Consider a multipartite graph G with maximum degree at most $n - o(n)$, parts $V1, \ldots, Vk$ of size n eachand every vertex has at most $o(n)$ neighbors in any part Vi. Loh and Sudakov proved that any such G has an independent transversal. They further conjectured that the vertex set of G can be decomposed into pairwise disjoint independent transversals. We resolve this conjecture approximately by showing that G contains $n - o(n)$ pairwise disjoint independent transversals. As applications, we give approximate answers to questions of Yuster, and of Fischer, Kühn, and Osthus.

Joint work with Debsoumya Chakraborti.

P8: New convergence results on the primal type algorithms for the distributed optimization

Woocheol Choi

Sungkyunkwan University, Korea

Distributed optimization is a concept of optimization that a group of agents connected by a network collaborate to find a minimizer of a global cost which is a sum of local costs of agents. It has been studied widely in the last decades as it appears in various fields such as multi-robot/multi-drone system and federated learning for machine learning problems. There are two types of algorithms: primal type algorithms which do not share the gradient information of agents and primal-dual type algorithms which share the gradient information of agents. In this talk, I will introduce new convergence results for the primal type algorithms.

A: Algebra, Geometry and Topology

A1: Betti number growth polynomials of braid groups on graphs with circumference 1

Byung Hee An

Kyungpook National University, Korea

The unordered configuration space on a space X, denoted by $B_k(X)$ is the space consisting of indistinguishable distinct k points in X, whose homotopy invariants such as homotopy groups and homology groups can be used to obtain invariants of X which are finer than homotopy invariants of X.

In particular, it is known that for a graph Γ, the i-th betti number $P_i^\Gamma(k)$ is eventually a polynomial of k, and its leading term is related with a certain combinatorial invariant of Γ. However, in general, it is unknown how to compute $P_i^\Gamma(k)$ efficiently and what coefficients other than the leading term means.
In this talk, we will consider a family of graphs with circumference 1, called *bunches of grapes*, and provide an efficient way to compute $P_i^\Gamma(k)$ and describe the meaning of all coefficients for bunches of grapes. This is a joint work with Jangsoo Kim (Sungkyunkwan University).

A2: Quasi-redirecting boundaries of non-positively curved groups

Nguyen Thanh Hoang

FPT University, Danang, Vietnam

Qing-Rafi recently introduced a new boundary for metric spaces called the quasi-redirecting (QR) boundary. The QR boundary is invariant under quasi-isometries, is often compact, and contains sublinearly Morse boundaries as topological subspaces. However, it is unknown whether all finitely generated groups have well-defined QR boundaries. In this talk, we demonstrate that the quasi-redirecting boundary is well-defined as a topological space for several groups of nonpositive curvature. Additionally, we provide a complete description of the QR boundaries for admissible groups that act geometrically on CAT(0) spaces. This is joint work with Alex Margolis and Yulan Qing.

A3: The quantum Lefschetz principle

Jeongseok Oh

Seoul National University, Korea

"Quantum Lefschetz" is a pretentious name for understanding how moduli spaces – and their virtual cycles and associated invariants – change when we apply certain constraints. (The original application is to genus 0 curves in $\mathbb{P}^4$ when we impose the constraint that they lie in the quintic 3-fold.)

When it doesn't work there are fixes (like the p-fields of Guffin-Sharpe-Witten/Chang-Li) for special cases associated with curve-counting. We will describe joint work with Richard Thomas developing a general theory.

A4: On the Higgs bundles and the Hitchin fibrations

Do Viet Cuong

VNU University of Science, Hanoi, Vietnam

The moduli space of Higgs bundles on a projective curve has many applications in geometry and Langlands program. It plays an important role in the study of representation of the fundamental group of the curve. Ngo observed that for curves defined over finite fields, the adelic description of the stack of Higgs bundles on the curve is related to spaces occurring in the study of the Langlands Shelstad trace formula and used it to prove the Langlands-Shelstad fundamental lemma. (Roughly speaking, Ngo's proof is the combination of a detailed study of the geometry of the Hitchin fibration - the morphism from the moduli space of Higgs bundles to characteristic polynomials, and that of the Beilinson-Bernstein-Deligne decompostion theorem in this special context). In this talk, I would like to convince audiences the important of the moduli space of Higgs bundles and to introduce some related problems which I am interested in.

A5: On singular del Pezzo surfaces embedded in weighted projective spaces

Joonyeong Won

Ewha Womans University, Korea

The smooth del Pezzo surfaces are among the most familiar, and fundamental, objects in algebraic geometry. As a generalization of it, we discuss some properies of singular del Pezzo surfaces embedded in weighted projective spaces, in particular, K-stability and the existence of -K-polar cylinder.

A6: Obstructions to sliceness via equivariant theory

JungHwan Park

Korea Advanced Institute of Science and Technology, Korea

A knot in the three-sphere is called *slice* if it bounds a smoothly embedded disk in the four-ball. One of the central problems in low-dimensional topology is to determine which knots are slice. In this talk, we survey recent developments in slicing obstructions, focusing on the existence of equivariant cobordisms between 3-manifolds with specific topological properties.

A7: On CR maps of hyperquadrics and Winkelmann hypersurfaces with vanishing geometric rank

Duong Ngoc Son

Phenikaa University, Vietnam

In this talk, we discuss the relation between the notion of geometric rank of Huang for CR sphere maps and the CR Ahlfors derivative constructed by B. Lamel and the speaker. We also discuss a recent result, joint with M. Reiter, about CR maps into the Winkelmann hypersurface with vanishing geometric rank.

A8: Cluster algebras and monoidal categories

Myungho Kim

Kyung Hee University, Korea

Cluster algebra is a special kind of commutative algebra introduced by Fomin and Zelevinsky in the early 2000s. Specifically, a cluster algebra is a subring generated from a field of rational functions with special elements called cluster variables, and the process of generating new cluster variables from given cluster variables is called mutation. A monoid category is called a monoidal categorification of a given cluster algebra if the Grothendieck ring is isomorphic to the cluster algebra and the cluster monomials correspond to simple objects.

In this talk, we will review the definition of cluster algebras and look at some examples of monoidal categorifications that arise in the representation theory of quantum affine algebras and quiver Hecke algebras. All of these examples are from joint work with Seok-Jin Kang, Masaki Kashiwara, Se-jin Oh, and Euiyong Park.

A9: Williams' Conjecture holds for graphs of Gelfand-Kirillov dimension 3

Tran Giang Nam

Institute of Mathematics, VAST, Vietnam

Shifts of finite type are central objects in the theory of symbolic dynamics; an isomorphism between two shifts of finite type is called a conjugacy. Up to conjugacy, every shift of finite type is conjugate to the edge shift associated with an essential graph. Determining whether two shifts of finite type are conjugate is in general a difficult problem. In his seminal paper entitled "Classification of subshifts of finite type, Ann. Math. 98 (2) (1973), 120-153.", Williams introduced the notions of shift equivalence (SE) and strong shift equivalence (SSE), which are more tractable. Williams showed that strong shift equivalence completely characterizes conjugacy, and described SSE as the equivalence relation generated by the graph moves of in/out-splitting and their inverses. Shift equivalence is a weaker equivalence relation than SSE, and is also more computable. Williams originally asserted that SE is equivalent to SSE. Although he identified a flaw in the proof that $SE \Rightarrow SSE$ a year later, it took 25 years before a counterexample to $SE \Rightarrow SSE$ was found, by Kim and Roush. Identifying classes of shifts for which SE and SSE are equivalent is an open problem. In this talk, we prove that the notions of SSE and SE coincide for graphs of Gelfand-Kirillov dimension 3. This is joint work with Roozbeh Hazrat and Tran Quang Do.

A10: K-stability of blow-ups of the weighted projective planes

In-Kyun Kim

Korea Institute for Advanced Study, Korea

Smooth del Pezzo surfaces are fundamental objects in algebraic geometry, arising as blow-ups of general points in $\mathbb{P}^2$. The blow-ups of the weighted projective plane $\mathbb{P}(1,1,n)$ can be regarded as natural generalizations of these surfaces. Weighted projective planes themselves play a key role in algebraic geometry and are closely connected to Sasakian and symplectic geometry.

The $K-$stability of smooth del Pezzo surfaces is well understood. For instance, while $\mathbb{P}^2$ is K-polystable, it becomes K-unstable after one or two blow-ups, regains K-stability after three, and retains this stability until the Fano condition is violated after eight blow-ups.

In this talk, we investigate the K-stability of blow-ups of $\mathbb{P}(1,1,n)$ and demonstrate that singular del Pezzo surfaces arising from $n+4$ blow-ups are $K-$stable. This result highlights a parallel between the stability patterns of $\mathbb{P}^2$ and $\mathbb{P}(1,1,n)$, shedding light on the broader relationship between blow-ups and $K-$stability in algebraic geometry.

A11: First order rigidity of manifold homeomorphism groups

Sang-Hyun Kim

Korea Institute for Advanced Study, Korea

Two groups are elementarily equivalent if they have the same sets of true first order group theoretic sentences. We prove that if the homeomorphism groups of two compact connected manifolds are elementarily equivalent, then the manifolds are homeomorphic. This generalizes Whittaker's theorem on isomorphic homeomorphism groups (1963) without relying on it. Joint work with Thomas Koberda (UVa) and Javier de la Nuez-Gonzalez (KIAS).

A12: Pinchuk scaling method and characterization of pseudoconvex domains in $\mathbb{C}^n$

Ninh Van Thu

Hanoi University of Science and Technology, Vietnam

In this talk, we consider an h-extendible domain $\Omega \subset \mathbb{C}^{n+1}$ with noncompact automorphism group. Let $\{\varphi_j(a)\}$ be a sequence of automorphism orbits converging to a boundary point ξ_0, where $a \in \Omega$ and $\phi_j \in \mathrm{Aut}(\Omega)$. Let us fix a small neighborhood U_0 of ξ_0. By using the reasonable composition, say T_j, of polynomial automorphisms of $\mathbb{C}^{n+1}$, including translations and dilations, the sequence of domains $D_j := T_j(U_0 \cap \Omega)$ converges normally to a model M_P, given by

$$M_P := \{(z, w) \in \mathbb{C}^n \times \mathbb{C} \colon \mathrm{Re}(w) + P(z, \bar{z}) < 0\},$$

where P is a real-valued polynomial on $\mathbb{C}^n$. One observes that the model M_P depends heavily on the boundary behavior of $\{\varphi_j(a)\}$. More precisely, the boundary behavior of $\{\varphi_j(a)\}$ suggests some choice of dilations. The purpose of this talk is to give a characterization of models when the automorphism orbit $\{\varphi_j(a)\}$ accumulates at ξ_0 "very" tangentially to $\partial\Omega$. This is a joint work with Nguyen Quang Dieu and Nguyen Thi Kim Son.

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A13: Rational curves in the Mukai-Umemura variety

Kiryong Chung

Kyungpook National University, Korea

Let X be the prime Fano threefold of index one, degree 22, and $\mathrm{Pic}(X) \cong \mathbb{Z}$. Such a threefold X can be realized by a regular zero section $\mathbf{s}$ of $\bigwedge^2 \mathcal{F}^{*\oplus 3}$ over a Grassmannian variety $\mathrm{Gr}(3, V)$, $\dim V = 7$ with the universal subbundle $\mathcal{F}$. If the section $\mathbf{s}$ is given by the net of the SL_2-invariant skew forms, we call it by Mukai-Umemura (MU) variety. In this paper, we prove that the Hilbert scheme of rational quartic curves in the MU-variety is smooth and compute its Poincare polynomial by applying the Białynicki-Birula's theorem. This is a joint work with Jaehyun Kim (EWU) and Jeong-Seop Kim (KIAS).

A14: Modified defect relation for Gauss maps of minimal surfaces with hypersurfaces of projective varieties in subgeneral position and related problems

Si Duc Quang

Hanoi National University of Education, Vietnam

The purpose of this talk is twofold. Firstly, we present the modified defect relations for Gauss maps of minimal surfaces with hypersurfaces of projective varieties in the subgeneral position. Secondly, we talk about some related problems of the modified defect relation for Gauss maps, such as the Gauss curvature estimate and the unicity of Gauss maps sharing hypersurfaces with weights.

A15: The rational torsion subgroups of modular Jacobian varieties

Hwajong Yoo

Seoul National University, Korea

For an abelian variety A defined over $\mathbf{Q}$, the set of all rational points on A forms a finitely generated abelian group. The torsion part of this group, called the *rational torsion subgroup*, is an important arithmetic invariant of A. In this talk, we introduce some ideas to compute this group when A is the Jacobian variety of the modular curve $X_0(N)$.

A16: Some local-global principles and applications

Nguyen Quoc Thang

Institute of Mathematics, VAST, Vietnam

We discuss some new local-global principles for algebraic groups and their applications.

C: Combinatorics and Discrete Mathematics

C1: Enumeration of multiplex juggling card sequences using generalized $q-$derivatives

Jang Soo Kim

Sungkyunkwan University, Korea

In 2019, Butler, Choi, Kim, and Seo introduced a new type of juggling card that represents multiplex juggling patterns in a natural bijective way. They conjectured a formula for the generating function for the number of multiplex juggling cards with capacity. In this paper we prove their conjecture. More generally, we find an explicit formula for the generating function with any capacity. We also find an expression for the generating function for multiplex juggling card sequences by introducing a generalization of the q-derivative operator. As a consequence, we show that this generating function is a rational function.

C2: Polynomial images: Discrete and Continuous

Pham Van Thang

VNU University of Science, Hanoi, Vietnam

In this talk, I present some recent progress on the Elekes–Rónyai's conjecture for quadratic polynomials in three variables in the continuous setting. This is based on joint work with Chun-Yen Shen, Doowon Koh, and Sung-Yi Liao.

C3: Ruling out two infinite families of putative strongly regular graphs using generalized methods

Jongyook Park

Kyungpook National University, Korea

In this talk, we disprove the existence of two infinite families of putative strongly regular graphs (SRGs) with parameters (n, k, λ, μ), where (n, k, λ, μ) is one of the

following:

$$(1+k+\frac{k(k-1-\lambda)}{\mu}, 2t(4t+1)\mu, (2t+1)(32t^3+4t-1), (2t+1)(8t^2+1))$$

or

$$(1+k+\frac{k(k-1-\lambda)}{\mu}, (2t+1)(4t+3)\mu, (2t+2)(32t^3+64t^2+44t+9), (2t+2)(8t^2+12t+5)).$$

Building on Koolen and Gebremichel's work for $t = 1$, we generalize their method to all $t \geq 1$, using restrictions on clique sizes and coclique bounds. The approach is effective in ruling out these families and can potentially disprove other SRGs. This is joint work with Jack Koolen, Brhane Gebremiche and Jeong Rye Park.

C4: On the number of k-independent sets of $\mathbf{W}_p$ graphs

Do Trong Hoang

Hanoi University of Science and Technology, Vietnam

Let G be a graph of order n. For a positive integer p, G is called a $\mathbf{W}_p$ graph if $n \geq p$ and any p pairwise disjoint independent sets in G can be extended to p pairwise disjoint maximum independent sets. In this talk, we will present fundamental results on the class of $\mathbf{W}_p$ graphs, including properties and structural insights. Additionally, we will discuss the number of k-independent sets in such graphs. Recent joint results obtained in collaboration with colleagues will also be presented.

C5: Unimodality of the independence polynomial of $G \circ (K_p \cup K_q)$

Pham My Hanh

Hanoi University of Science and Technology, Vietnam

In this talk, we primarily focus on the unimodal property of independence polynomials $I(G\circ(K_p\cup K_q); x)$. More precisely, we prove that the independence polynomial $I(G \circ (K_p \cup K_q); x)$ is unimodal for every graph G, whenever the positive integers p and q are large enough. In addition, we establish several inequalities involving the coefficients of $I(G \circ (K_p \cup K_q); x)$ for arbitrary p and q. Consequently, we propose an equivalent assertion to the open Conjecture of Alavi, Malde, Schwenk and Erdös about the unimodality of independent polynomial of trees.

This is a joint work with Dr. Do Trong Hoang (Hanoi University of Science and Technology, Vietnam), Prof. Vadim E. Levit (Ariel University, Israel) and Prof. Eugen Mandrescu (Holon Institute of Technology, Israel).

C6: A matrix variant of the Erdős-Falconer distance problems over finite field

Ngo Trung Hieu

Institute of Mathematics, VAST, Vietnam

In 2007, Iosevich and Rudnev initiated the study of the Erdős-Falconer distance problems in vector spaces over finite fields. Their pioneering work generated a surge of research on variations of distance-type problems, albeit still in the context of vector spaces over finite fields. In this talk, we will discuss a matrix analog of the Erdős-Falconer distance problems and provide several non-trivial results in this direction. In our analysis, there arise interesting quadratic matrix Gauss sums, which deserve further study.

C7: The complexity of some reconfiguration problems on graphs with distance constraints

Hoang Anh Duc

VNU University of Science, Hanoi, Vietnam

Over the past few decades, "Combinatorial Reconfiguration" has emerged in various areas of computer science. In a reconfiguration variant of a computational problem (e.g., Satisfiability, Independent Set, Vertex-Coloring, etc.), a transformation rule describes an adjacency relation between feasible solutions (e.g., satisfying truth assignments, independent sets, proper vertex-colorings, etc.) of the problem. A typical example is the well-known Rubik's cube puzzle, where each configuration of the cube corresponds to a feasible solution, and two configurations (solutions) are adjacent if one can be obtained from the other by rotating a face of the cube by either 90, 180, or 270 degrees. A classic question is, given two feasible solutions S and T, whether there exists a sequence of adjacent feasible solutions between them. Reconfiguration problems have been extensively studied for several classic computational problems, including Independent Set, Dominating Set, and Vertex-Coloring. In this talk, I will briefly introduce some reconfiguration variants of these problems and their computational complexities under certain distance constraints. This is based on recent joint works with Niranka Banerjee (Kyoto University, Kyoto, Japan) and Christian

Engels (National Institute of Informatics, Tokyo, Japan).

C8: Geometric distance-regular graphs

Sejeong Bang

Yeungnam University, Korea

A non-complete distance-regular graph is called geometric if it is the point graph of a partial linear space in which the set of lines is a set of Delsarte cliques. In this talk, we consider several properties of geometric distance-regular graphs. We show tight bounds for the diameter of geometric antipodal distance-regular graphs with an induced subgraph $K_{2,1,1}$ by studying parameters for geometric antipodal distance-regular graphs.

C9: A new variant of Tverberg theorem

Minki Kim

Gwangju Institute of Science and Technology, Korea

In d-dimensional Euclidean space, Tverberg theorem asserts that every $(k-1)(d+1)+1$ points can be partitioned into k parts whose convex hulls intersect. Such a partition is called a Tverberg k-partition. Recently, we proved a stronger form: every set S with more that $(k-1)(d+1)$ points admits a partition P of S into k parts and a subset T of size $(k-1)(d+1)$ such that P induces a Tverberg k-partition on any subset R of S that is obtained by adding a point from $S-T$ to T. I will give a proof of this variant of Tverberg theorem and present an application to tolerated Tverberg theorem.

C10: Community detection in directed graphs using stationary distribution and hitting times methods

Do Duy Hieu

Institute of Mathematics, VAST, Vietnam

Community detection has been extensively studied using various algorithms. One of the most powerful algorithms for undirected graphs is Walktrap, which calculates the distance between vertices by employing random walks and evaluates clusters using modularity based on vertex degrees. While several approaches have been proposed to extend this method to directed graphs, they have yet to prove sufficiently effective. This study investigates the Walktrap algorithm (Pons and Latapy, J Graph Algorithms Appl 10:191–218, 2006) and extends it to directed graphs. We propose a novel approach where the distance between vertices is defined using hitting times. This definition is highly effective, as efficient algorithms for computing hitting times and stationary distributions have been developed, ensuring good computational complexity. Our proposed method is particularly useful for directed graphs, with the results for undirected graphs being special cases. Furthermore, we have implemented our algorithms to validate their practicality and effectiveness.

C11: Counting homomorphisms in antiferromagnetic graphs via Lorentzian polynomials

Joonkyung Lee

Yonsei University, Korea

An edge-weighted graph G, possibly with loops, is said to be *antiferromagnetic* if it has nonnegative weights and at most one positive eigenvalue, counting multiplicities. The number of graph homomorphisms from a graph H to an antiferromagnetic graph G generalises various important parameters in graph theory, including the number of independent sets and proper vertex colourings.

We prove a number of homomorphism inequalities for antiferromagnetic target graphs G. In particular, we prove that, for any antiferromagnetic G,

$$|\operatorname{Hom}(K_d, G)|^{1/d} \leq |\operatorname{Hom}(K_{d,d} \setminus M, G)|^{1/(2d)}$$

holds, where $K_{d,d} \setminus M$ denotes the complete bipartite graph $K_{d,d}$ minus a perfect matching. This confirms a conjecture of Sah, Sawhney, Stoner and Zhao for complete graphs K_d. Our method uses the emerging theory of Lorentzian polynomials due to Brändén and Huh, which may be of independent interest.

Joint work with Jaeseong Oh and Jaehyeon Seo.

C12: α-chromatic symmetric functions

Meesue Yoo

Chungbuk National University, Korea

In 1988, Macdonald introduced a remarkable new basis for the space of symmetric functions which are now called Macdonald polynomials. They were immediately hailed as a breakthrough in symmetric function theory, as they contained most of the previously known symmetric function families as special cases, and yet satisfied many interesting properties. Upon the introduction, Macdonald also defined the integral form Macdonald polynomials $J_\mu(X;q,t)$ and conjectured that they can be expanded in terms of modified Schur functions $s_\lambda[X(1-t)]$ with coefficients in $\mathbb{N}[q,t]$. This is the Macdonald positivity conjecture and it has been proved by Haiman in 2001 algebraically, but no combinatorial formulas are known in general. In the same vein of approaching to find combinatorial formulas, Haglund conjectured that for any $k \in \mathbb{N}$,

$$\left\langle \frac{J_\mu(X;q,q^\alpha)}{(1-q)^{|\mu|}} \right\rangle \in \mathbb{N}[q].$$

On the other hand, (integral form) Jack polynomials can be realized as

$$J_\mu^{(\alpha)}(X) = \lim_{t\to 1} \frac{J_\mu(X;t^\alpha,t)}{(1-t)^{|\mu|}}.$$

Note that if we let $\tilde{J}_\mu^{(\alpha)}(X) = \lim_{q\to 1} \frac{J_\mu(X;q,q^\alpha)}{(1-q)^{|\mu|}}$, then $\tilde{J}_\mu^{(\alpha)}(X) = \alpha^n J_\mu^{(\alpha^{-1})}(X)$. Their Schur coefficients are not α-positive, however, Alexandersson-Haglund-Wang noticed and conjectured that the Schur coefficients are positive in binomial bases $\left\{\binom{\alpha+k}{n}\right\}_{0\le k\le n-1}$ and $\left\{\binom{\alpha}{k}k!\right\}_{1\le k\le n}$.

As the integral form Macdonald polynomials and modified Macdonald polynomials are related via plethystic substitution, we go over some techniques to deal with such relations and present how we applied those techniques to α-chroamtic symmetric functions in recent research.

This is based on joint work with Jim Haglund and Jaeseong Oh.

C13: The complexity of matroid homomorphism reconfiguration

Cheolwon Heo

Korea Institute for Advanced Study, Korea

For a given binary matroid N, we consider a reconfiguration problem of binary matroid homomorphisms to N. Specifically, for a binary matroid M and two matroid homomorphisms ϕ_1 and ϕ_2 from M to N, we want to determine whether there exists a sequence of matroid homomorphisms from ϕ_1 to ϕ_2 such that consecutive homomorphisms differ precisely on a cocircuit of N. We show that this problem is trivial when N is isomorphic to the graphic matroid $M(K_2)$, and that the problem is PSPACE-Complete when N is isomorphic to the graphic matroid $M(K_t)$ for every $t \geq 3$. This is joint work with Mark Siggers at Kyungpook National University.

D: Differential Equations and Dynamical Systems

D1: Serrin-type condition to dhear thickening non-Newtonian fluid

Hyeong-Ohk Bae

Ajou University, Korea

We consider a weak solution to the equations of shear thickening incompressible fluid. We prove that under a Serrin-type condition imposed on the velocity field u, the field enjoys a higher integrability properties, which ensures that u is strong. In particular, we prove that for powers law $q \geq \frac{11}{5}$ any weak solution is strong.

D2: Sobolev inequalities on the standard sphere: old and new

Ngo Quoc Anh

VNU University of Science, Hanoi, Vietnam

The classical Sobolev inequality on $H^1(\mathbf{R}^n)$ asserts that the embeding $H^1(\mathbf{R}^n) \hookrightarrow L^{\frac{2n}{n-2}}(\mathbf{R}^n)$ with $n \geq 3$ is continous, namely there holds

$$\Big(\int_{\mathbf{R}^n} |u|^{\frac{2n}{n-2}} dx \Big)^{\frac{n-2}{n}} \leq K \int_{\mathbf{R}^n} |\nabla u|^2 dx$$

for any continuously differentiable function u with compact support, with an optimal constant K depending only on n. Since $\mathbf{R}^n$ and the standard sphere $\mathbb{S}^n \subset \mathbf{R}^{n+1}$ are conformally equivalent natually by the stereographic projection, there is an equivalent version of the classical Sobolev inequality on $H^1(\mathbb{S}^n)$ leading to the optimal inequality

$$\Big(\int_{\mathbb{S}^n} |v|^{\frac{2n}{n-2}} d\mathrm{vol}_{\mathbb{S}^n} \Big)^{\frac{n-2}{n}} \leq \frac{4}{n(n-2)} \int_{\mathbb{S}^n} |\nabla v|^2 d\mathrm{vol}_{\mathbb{S}^n} + \int_{\mathbb{S}^n} |v|^2 d\mathrm{vol}_{\mathbb{S}^n}.$$

By making use of the conformal Laplacian on $\mathbb{S}^n$ defined by $L_n^2 : v \mapsto -\Delta v + (n(n-2)/4)v$, it appears that the preceding inequality can be rewritten as

$$\Big(\int_{\mathbb{S}^n} |v|^{\frac{2n}{n-2}} d\mathrm{vol}_{\mathbb{S}^n} \Big)^{\frac{n-2}{n}} \leq \frac{4}{n(n-2)} \int_{\mathbb{S}^n} v L_n^2(v) d\mathrm{vol}_{\mathbb{S}^n}.$$

In this talk, by focusing on the setting of the standard sphere $\mathbb{S}^n$, I will discuss various choices of differential operators in place of L_n^2 leading to many interesting Sobolev inequalities. This boils down to extensive studies over the last few decades.

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D3: Critical thresholds in pressureless Euler–Poisson equations with background states

Young-Pil Choi

Yonsei University, Korea

In this talk, we discuss the critical threshold phenomena in a large class of one-dimensional pressureless Euler–Poisson (EP) equations, with non-vanishing background states. First, we establish local-in-time well-posedness in proper regularity spaces, which are adapted for a certain *neutrality condition* to hold. Next, we study the critical threshold phenomena in the neutrality-condition-satisfying pressureless EP systems, where we distinguish between two cases; attractive and repulsive forces. As an application, we analyze the critical thresholds for the damped EP system for cold plasma ion dynamics, where the density of electrons is given by the *Maxwell–Boltzmann relation*. This talk is based on a joint work with Dong-ha Kim, Dowan Koo, and Eitan Tadmor.

D4: Mathematical Modeling of Multi-Fashion Trend: Flocking and Differentiation

Jane Yoo

Ajou University, Korea

Multiple sub-trends are often observed from people conforming to a fashion trend in a personal way. We suggest a mathematical model of multi-fashion trends by applying the interactive force of flocking and differentiation to a sole fashion trend model. Our model explains the dynamics of a sub-trend into two steps: its *emergence*

and development into a *segment* of the overall trend. We examine the mathematical properties of the model rigorously and show roles of parameters in explaining real trend data by various numerical simulations.

This is a joint work with Hyeong-Ohk Bae, Seung Yeon Cho, Seok-Bae Yun.

D5: Local limit theorem of the Brownian motion on simplicial trees

Soonki Hong

Pohang University of Science and Technology, Korea

In this talk, I will present the local limit theorem for Brownian motion on a tree where all edges have unit length, with a discrete group acting isometrically and geometrically on the tree. The theorem characterizes the asymptotic behavior of the transition probability density (heat kernel) as time tends to infinity.

D6: Physics-informed neural networks for the pseudo-two-dimensional model of Lithium ion battery

Myeong-Su Lee

Korea Advanced Institute of Science and Technology, Korea

The pseudo-two-dimensional (P2D) model is a widely used mathematical framework for describing the electrochemical processes in Li-ion batteries. It consists of a system of nonlinear partial differential equations coupled with nonlinear relations, such as the Butler-Volmer equation. In this talk, we explore the application of Physics-Informed Neural Networks (PINNs) to solve the P2D model. However, the inherent nonlinearities in the model often lead to inaccuracies when using standard PINN approaches. To overcome these challenges, we propose two strategies: (1) introducing bypassing terms to enhance training stability and (2) incorporating secondary conservation laws to improve solution accuracy. Through numerical experiments, we demonstrate the remarkable effectiveness of our proposed strategies.

D7: Non-existence results of positive solutions for a system of elliptic inequalities on weighted graphs

Duong Anh Tuan

Hanoi University of Science and Technology, Vietnam

In this talk, we are concerned with the existence and non-existence of positive solutions for a system of inequalities

$$\begin{cases} -\Delta u \geq h_1 v^p \text{ in } V, \\ -\Delta v \geq h_2 u^q \text{ in } V, \end{cases}$$

where V is an infinite, connected, locally finite weighted graph, $p > 1, q > 1$, h_1, h_2 are positive potential functions and Δ is the standard graph Laplacian. We prove that, under some growth assumptions on weighted volume of balls and some properties of the graph, any nonnegative solution of the above system must be trivial. We also discuss the sharpness of the obtained result.

D8: Finding minimal modules for substitution tilings

Jeong-Yup Lee

Catholic Kwandong University, Korea

Substitution tilings have been good mathematical models in the study of dynamical systems. For the study of substitution tiling dynamics, it is important to know the minimal modules on which substitution tilings lie.

In the case that the expansion maps of substitution tilings are diagonalizable, the minimal modules for substitution tilings are known under the assumption of finite local complexity(FLC). But the expansion maps are non-diagonalizable, nothing much is known.

Here we look at the non-diagonalizable case and try to find the minimal modules for substitution tilings under certain conditions.

D9: Solvability and stability of stochastic singular systems

Do Duc Thuan

Hanoi University of Science and Technology, Vietnam

In this talk, we present differential-algebraic equations (DAEs) and singular difference equations subject to stochastic perturbations. Stochastic singular systems with delay are also investigated. We introduce the index-ν concept and establish formulas of solution for these equations. After that the stability is studied by using the method of Lyapunov functions and comparison principle. The robust stability of DAEs with respect to stochastic perturbations is also studied. A formula of the stability radius for stochastic DAEs is derived. Some example are given to illustrate the obtained results.

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D10: Dynamical zeta function of non-compact high-dimensional weighted complexes

Sanghoon Kwon

Catholic Kwandong University, Korea

In this talk, we explore the geometric zeta function associated with non-uniform triangle complexes arising from the projective general linear group over fields of positive characteristic. We begin by reviewing basic concepts, including the zeta functions of subshifts of finite type and the Ihara zeta function of graphs. Building on this groundwork, we extend the discussion to zeta functions for infinite weighted graphs (Deitmar-Kang, *Michigan Math. J.* 2018) and higher-dimensional simplicial complexes (Kang-Li, *Adv. Math.* 2014).

Finally, we integrate these approaches to describe the zeta function of a weighted complex obtained from a non-compact quotient of PGL_3. The key idea involves

applying trunctation to compute the determinant of a large matrix and then taking the limit. This talk is based on joint work with Soonki Hong.

D11: The θ-scheme for Caputo fractional differential equations

Phan Thi Huong

Le Quy Don Technical University, Vietnam

In this talk, we first construct the θ-numerical scheme for Caputo fractional differential equations of order $\alpha \in (0, 1)$ with vector fields satisfying a standard Lipschitz continuity condition in the state variable and a Hölder continuity condition in the time variable. We then show the convergence rate of this scheme and provide a numerical example to illustrate the theoretical results.

This is a joint work with Prof. T. S. Doan and Prof. P. E. Kloeden.

D12: Regularity in time of solutions for semilinear fractional reaction–subdiffusion equations in bounded domains

Tran Van Tuan

Hanoi Pedagogical University 2, Vietnam

In this talk, we deal with the regularity in time of solutions for fractional reaction-subdiffusion (FrRS) equations in bounded domains involving nonlinear perturbations. By establishing regularity estimates in both time and space of the resolvent operator and employing fixed point theorems, we prove some results on the existence and regularity in time of solutions to FrRS in two different cases of nonlinear perturbations, namely sublinear and superlinear cases. Based on these results, we analyze the existence as well as regularity of solutions in an inverse source problem driven by FrRS with the additional observations given at terminal time.

D13: Nonlinear scattering of 3D Maxwell-Dirac equation

Yonggeun Cho

Jeonbuk National University, Korea

In this talk we consider 3D Maxwell-Dirac equation in the Lorenz gauge for a class of suitably smooth and small initial data.

We are going to discuss that the long-range interaction between spinor and gauge fields gives rise to a nonlinear scattering with phase modification. To this end we will use a bootsrapping argument starting from a priori assumption of scattering norm and weighted energy norm bounds.

This will be based on the vector-field energy estimates and normal form method.

D14: Fluctuation of chemical distance in Bernoulli percolation

Can Van Hao

Institute of Mathematics, VAST, Vietnam

In this talk, we consider supercritical Bernoulli percolation on the lattice $\mathbb{Z}^d$ and study the graph distance on the infinite cluster. After an overview of the linear growth of model, we will discuss on the subdiffusive behavior of the fluctuation. Our approach relies on concentration inequalities inspired by similar work in first passage percolation, combined with new tools to address the challenge posed by the infinite weight of the model. Based on joint work with Nguyen Van Quyet.

D15: Spatially homogeneous solutions to the Einstein-Boltzmann system with soft potentials

Ho Lee

Kyung Hee University, Korea

In this talk we study a simple cosmological model described by the Einstein-Boltzmann system. We assume the Bianchi I symmetry to describe an expanding, spatially homogeneous universe. By the Boltzmann equation we describe a universe filled with a relativistic gas of colliding, massive particles. We obtain the global existence and isotropization of the universe for small initial data.

D16: Projector approach for constructing asymptotic solution of singularly perturbed discrete-time weakly optimal control problem in the critical case

Nguyen Thi Hoai

VNU University of Science, Hanoi, Vietnam

Our work deals with constructing an asymptotic approximation to a solution to a linear-quadratic optimal control problem with discrete-time state in critical case. The asymptotics contains a regular series and two boundary series in the vicinities of two fixed end points of a fixed interval of variation.

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D17: On a class of subdiffusion equations in the whole space

Tran Dinh Ke

Hanoi National University of Education, Vietnam

We deal with a class of semilinear subdiffusion equations which describes anomalous diffusion processes in the whole space. The well-posedness and regularity of solutions will be analyzed by using the resolvent theory, the Fourier analysis and the fixed point arguments.

D18: Gradient regularity for nonlinear elliptic equations involving fractional maximal operators

Tran Minh Phuong

Ton Duc Thang University, HoChiMinh City, Vietnam

We construct an efficient approach to dealing with global regularity estimates for solutions to a class of elliptic boundary value problems under weak data assumptions. Moreover, in our study, we leverage the advantage of level-set inequalities on weighted (or non-weighted) fractional maximal distribution functions to extend regularity estimates in a wide range of function spaces. This approach inspired several subsequent developments, including obstacle problems, asymptotically regular problems, problems with non-standard growth, problems of calculus of variations, and many others. In general, these problems have appeared in various mathematical models arising from physics and fluid mechanics.

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D19: Analytical theory of score-based diffusion models with multiplicative noise conditioning

Doheon Kim

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Score-based diffusion models generate new samples by learning the score associated with a diffusion process. When the score is accurately approximated, the effectiveness

of these models can be theoretically justified using differential equations related to the sampling process. Despite this, empirical evidence shows that models employing neural networks with multiplicative noise conditioning can still produce high-quality samples, even when their capacity is clearly insufficient to learn the correct score. We offer a theoretical explanation for this phenomenon by examining the qualitative behavior of the differential equations governing the diffusion processes, utilizing appropriate Lyapunov functions for analysis.

D20: Decay character and semilinear structurally damped σ-evolution equations with time-dependent damping

Pham Trieu Duong

Hanoi National University of Education, Vietnam

In this talk we first study the Cauchy problem to the linear damped σ-evolution equation with time-dependent damping in the effective cases

$$u_{tt} + (-\Delta)^{\sigma} u + b(t)(-\Delta)^{\delta} u_t = 0,$$

and investigate the decay rates of the solution and its derivatives that are expressed in terms of the decay characters of the initial data $u_0(x) = u(0,x)$ and $u_1(x) = u_t(0,x)$. We are also interested in the existence and decay rate of the global (in time) solutions with small data for the corresponding semilinear problem with the nonlinear term of power type $||D|^{\gamma} u|^p$. The blow-up results for solutions to the semilinear problem in the case $\gamma = 0$ are presented to illustrate the optimality of the exponent p of the nonlinear term obtained in the global existence theorem.

This is joint work with Cung The Anh and Phan Duc An.

O: Optimization and Data Science

O1: Exploring Turing Pattern Classification through Convolutional Neural Networks and Feature Engineering

Jaemin Shin

Chungbuk National Universtiy, Korea

This study explores the classification potential of Turing patterns with nonlinearity using Convolutional Neural Networks (CNNs). Spatial nonuniformity caused by Turing instability, observed in natural phenomena such as animal coat patterns and neural models, remains a challenging problem due to the difficulty in learning the parameters governing such pattern formation. We consider a minimal CNN structure to classify patterns based on the reaction-diffusion model. We leverage CNN components, including convolutional layers, activation functions, and pooling layers, to learn features crucial for recognizing the stability boundaries of Turing patterns. This approach aims to uncover potential applications of machine learning in understanding pattern formation mechanisms.

O2: Hamilton–Jacobi Based Policy-Iteration via Deep Operator Learning

Yeoneung Kim

Seoul National University of Science and Education, Korea

The framework of deep operator network (DeepONet) has been widely exploited thanks to its capability of solving high dimensional partial differential equations. In this paper, we incorporate DeepONet with a recently developed policy iteration scheme to numerically solve optimal control problems and the corresponding Hamilton–Jacobi–Bellman (HJB) equations. A notable feature of our approach is that once the neural network is trained, the solution to the optimal control problem and HJB equations with different terminal functions can be inferred quickly thanks to the unique feature of operator learning. Furthermore, a quantitative analysis of the accuracy of the algorithm is carried out via comparison principles of viscosity solutions. The effectiveness of the method is verified with various examples, including 10-dimensional linear quadratic regulator problems (LQRs). This work is joint with Jae Yong Lee at Chung-Ang University.

O3: A PINN approach for identifying governing parameters of noisy thermoacoustic systems

Hwijae Son

Konkuk University, Korea

In this talk, we discuss thermoacoustic instability in a combustor, which can be naturally translated into a system identification problem for the Fokker-Planck equation. We propose an algorithm based on Physics-Informed Neural Networks (PINNs) to solve this inverse problem. Specifically, we introduce a negative log-likelihood loss function that integrates the stochastic samples and the solution of the Fokker–Planck equation. The proposed framework is validated using the numerically generated signal and the experimental data obtained from an annular combustor, both before and after the supercritical Hopf bifurcation. The results of PINN-based system identification show good agreement with the actual system parameters and the original stochastic signal, with improved accuracy compared to established methods.

O4: Existence and stability of solutions for nonconvex optimization problems via asymptotic analysis

Nguyen Van Tuyen

Hanoi Pedagogical University 2, Vietnam

In this talk, we present some sufficient conditions for the nonemptiness and the compactness of the solution set of nonconvex optimization problems with unbounded constraint sets via asymptotic cones and generalized asymptotic functions. Next, we show that these conditions are also useful for studying the solution stability of nonconvex optimization problems under linear perturbations.

O5: Tilt stability for nonlinear programs

Nguyen Huy Chieu

Vinh University, Vietnam

Tilt stability, introduced by Poliquin and Rockafellar [SIAM J. Optim. 8 (1998), 287-299], is an important property of local minimizers. It guarantees that the local minimizer evolves uniquely in a Lipschitz continuous trajectory under small linear

perturbations, which is a highly desirable behavior from both theoretical and practical perspectives. The presentation focuses on discussing the tilt stability of local minimizers for nonlinear programs in finite dimensions. We will explore characterizations of tilt stability, providing insights into the conditions that guarantee this property. Additionally, we will present precise formulas for computing the exact bounds of tilt stability, enabling a quantitative assessment of the robustness of local minimizers.

O6: Characterizations of Farkas-type results involving linear-convex/concave systems with applications and generalization

Nguyen Dinh

International University, VNU-HCMC, Vietnam

The report firstly deals with the characterization of Farkas lemmas determining when the upperlevel/lowerlevel set of a convex function f contains a set of the form $C \cap \mathbb{A}^{-1}(D)$,

$$(\mathcal{A}_0) \quad x \in C \cap \mathbb{A}^{-1}(D) \implies f(x) \geq 0, \text{ or}$$
$$(\mathcal{A}'_0) \quad x \in C \cap \mathbb{A}^{-1}(D) \implies f(x) \leq 0,$$

where C and D are convex sets (not necessarily cones) in locally convex spaces X and Y, respectively, while $\mathbb{A}$ is a continuous linear operator from X to Y. Each of the mentioned characterizations of Farkas type lemma involves the closedness of certain subsets of either primal or dual spaces. The results are then applied to constrained convex optimization problems and functional approximation by polynomials.

The next part of the report devoted to some extensions of the results above to the system associated to the robust optimization problem

$$\inf_{x \in X} \left\{ \sup_{u \in U} F_u(x, 0_Y) \right\},$$

where U is an uncertainty set and $F_u \colon X \times Y \to \overline{\mathbb{R}}$ for each $u \in U$. Concretely, we search for the characterizations of the equivalence of the properties

$$(\mathcal{A}) \quad \sup_{u \in U} F_u(x, 0_Y) \geq 0 \ \text{ for all } x \in X,$$
$$(\mathcal{B}) \quad \exists (\bar{u}, \bar{\lambda}) \in U \times Y^* : F_{\bar{u}}(x, y) + \langle \bar{\lambda}, y \rangle \geq 0 \text{ for all } (x, y) \in X \times Y.$$

This equivalence is a kind of generalized Farkas lemma and also known as the *validity of robust* $S_{\{F_u\}_{u \in U}}$*-procedure*. We present primal and dual characterizations for this robust procedure.

Finally, we also establish characterizations for the *validity of robust generalized S-procedure with second member* $h \in \Gamma(X)$, whose corresponding statements are

$$(\mathcal{A}_h) \quad \sup_{u\in U} F_u(x, 0_Y) \geq h(x) \quad \text{for all} \quad x \in X,$$

$$(\mathcal{B}_h) \quad \begin{cases} \text{for any } a' \in \text{dom}h^* \text{ there exists } \ (\bar{u}, \bar{y}) \in U \times Y^* \text{ s.t.} \\ F_{\bar{u}}(x, y) + \langle \bar{\lambda}, y\rangle \geq \langle a', x\rangle - h^*(a'), \ \forall (x, y) \in X \times Y. \end{cases}$$

Here $\Gamma(X)$ is the set of all proper, convex and lower semi-continuous functions on X.

O7: Error bounds for a class of cone-convex inclusion problems

Hoang Ngoc Tuan

Hanoi Pedagogical University 2, Vietnam

In this talk, we present error bounds for convex-cone inclusions in finite dimensional settings of the form $f(x) \in K$ where K is a smooth cone and f is a continuously differentiable and K-concave function. It is shown that local error bounds for the inclusion can be characterized by the Abadie constraint qualification around the reference point. Moreover, when f is affine, we precisely identify the conditions under which the inclusion admits global error bounds. Some properties of smooth cones, as well as regular cones and strictly convex cones, are also discussed.

O8: Google PageRank and citation networks through the optimization lens

Vu Thi Huong

Institute of Mathematics, VAST, Vietnam, Digital Data and Information for Society, Science, and Culture, Zuse Institute Berlin, Germany

Google's search engine was co-founded by two computer scientists, L. Page and S. Brin, while they were both PhD students at Stanford University in 1998. Since then, Google has become an indispensable part of our modern lives, providing a huge source of human knowledge. Each time we search, Google returns a list of millions of web pages in less than a second. Normally, we follow the links at the top of the list and find that those are the most relevant. The algorithm behind this is PageRank, a link analysis method to rank web pages based on their "importance". In this talk, we will discuss some mathematical aspects of PageRank, its application in academic citation networks, and how it is viewed through the lens of convex optimization. This allows us to further discuss whether the Polyak step rule in the gradient descent method is an optimal choice, from both theoretical and computational perspectives.

O9: Mathematical theory of neural network approximation and its application to scientific machine learning

Seungchan Ko

Inha University, Korea

In recent years, modern machine learning techniques using deep neural networks have achieved tremendous success in various fields. From a mathematical point of view, deep learning essentially involves approximating a target function, relying on the approximation power of deep neural networks. Therefore, it is important to understand the approximation and generalization properties of neural networks in high dimensions. The primary objective of this talk is to mathematically analyze the approximation of neural networks within the classical numerical analysis framework. We will explore the proper regularity of target functions which is suitable for the neural network approximation, and investigate how these properties are reflected in the approximation and learning complexity of neural networks. Next, I will apply these theories to my recent work on the operator learning method for solving parametric PDEs. I will analyze the intrinsic structure of the proposed method through the theory described above, deriving some useful results both theoretically and practically. Furthermore, I will demonstrate some relevant numerical experiments, confirming that these theory-guided strategies can be utilized to significantly improve the performance of the method.

O10: Gradient flow and its numerical methods

Seunggyu Lee

Korea University, Korea

A gradient flow is a curve that follows the steepest descent direction in a function within metric space. It has been a valuable tool in the analysis of ODEs and PDEs and, recently, gradient flows under various distances have also emerged for potential use in scientific computing and machine learning. In this talk, we discuss the convex splitting scheme, which was proposed to solve gradient flows with unconditionally gradient energy stability.

O11: From few sequences to whole genomes: the next challenges in evolutionary studies

Le Si Vinh

University of Engineering and Technology, Vietnam National University, Vietnam

Reconstructing the evolutionary history of species represents a fundamental challenge in molecular biology and bioinformatics. Historically, this task was conducted using limited data. In this presentation, we explore computational methods for inferring evolutionary relationships among species based on whole-genome data. Furthermore, we highlight the potential of deep learning approaches for this problem while addressing critical challenges such as handling the unknown truths of evolutionary history.

O12: On barycenter computation: semi-unbalanced optimal transport-based method on Gaussians

Pham Huy Tung

VinAI, Vietnam

We explore a robust version of the barycenter problem among n centered Gaussian probability measures, termed Semi-Unbalanced Optimal Transport (SUOT)-based Barycenter, wherein the barycenter remains fxed while the others are relaxed using Kullback-Leibler divergence. We develop optimization algorithms on Bures-Wasserstein manifold, named the Exact Geodesic Gradient Descent and Hybrid

Gradient Descent algorithms. While the Exact Geodesic Gradient Descent method is based on computing the exact closed form of the frst-order derivative of the objective function of the barycenter along a geodesic on the Bures manifold, the Hybrid Gradient Descent method utilizes optimizer components when solving the SUOT problem to replace outlier measures before applying the Riemannian Gradient Descent. We establish the theoretical convergence guarantees for both methods and demonstrate that the Exact Geodesic Gradient Descent algorithm attains a dimension-free convergence rate. Finally, we conduct experiments to compare the normal Wasserstein Barycenter with ours and perform an ablation study.

Joint work with Ngoc Hai Nguyen, Dung Le, Hoang Phi Nguyen, Nhat Ho.

O13: Solving group-sparse problems via deep neural networks with theoretical guarantee

Hayoung Choi

Kyungpook National University, Korea

In this talk, we consider a group-sparse matrix estimation problem. This problem can be solved by applying the existing compressed sensing techniques, which either suffer from high computational complexities or lack of algorithm robustness. To overcome the situation, we propose a novel algorithm based on the deep neural network to simultaneously achieve low computational complexity and high robustness. Specifically, we map the original iterative shrinkage thresholding algorithm (ISTA) into an unrolled recurrent neural network (RNN), thereby improving the convergence rate and computational efficiency through end-to-end training. Moreover, the proposed algorithm unrolling approach inherits the structure and domain knowledge of the ISTA, thereby maintaining the algorithm robustness, which can handle non-Gaussian preamble sequence matrix in massive access. We further simplify the unrolled network structure with rigorous theoretical analysis by reducing the redundant training parameters. Furthermore, we prove that the simplified unrolled deep neural network structures enjoy a linear convergence rate. Extensive simulations based on various preamble signatures show that the proposed unrolled networks outperform the existing methods regarding convergence rate, robustness, and estimation accuracy.

O14: New interior-point methods for linear optimization problems

Gyeong-Mi Cho

Dongseo University, Korea

In this talk, we proposed new interior-point methods (IPMs) for linear optimization (LO) problem based on a generalized class of kernel functions, originally defined by Cho et al.(2021, J. Nonlinear and Convex Anal.). We have improved complexity by a constant factor over the original method.

New search directions and proximity measures are defined based on this kernel function. We proved that the complexity is $\mathcal{O}\left(\sqrt{n}(\log n)\log\frac{n\mu^0}{\epsilon}\right)$ for large-update methods and $\mathcal{O}\left(\sqrt{n}\log\frac{n\mu^0}{\epsilon}\right)$ for small-update methods, where n is a dimension of the problem, $\mu^0 > 0$, and $\epsilon > 0$. These represent the theoretically best complexity results for such methods so far. We also demonstrated better results compared to interior-point algorithms using other kernel functions in numerical tests.

Joint work with Jongkyu Lee, You-Young Cho and Yong-Hoon Lee.

O15: Commutation principles for nonsmooth variational problems on Euclidean Jordan algebras

Juyoung Jeong

Changwon National University, Korea

The commutation principle proved by Ramírez, Seeger, and Sossa in the setting of Euclidean Jordan algebras says that for a Fréchet differentiable function Θ and a spectral function F, any local minimizer or maximizer a of $\Theta + F$ over a spectral set $\mathcal{E}$ operator commutes with the gradient of Θ at a. In this paper, we improve this commutation principle by allowing Θ to be nonsmooth with regularity assumptions over it. For example, for the case of local minimizer, we show that a operator commutes with some element of the limiting (Mordukhovich) subdifferential of Θ at a provided that Θ is subdifferentially regular at a satisfying a qualification condition. For the case of local maximizer, we prove that a operator commutes with each element of the (Fenchel) subdifferential of Θ at a whenever this subdifferential is nonempty. As an application, we characterize the local optimizers of shifted strictly convex spectral functions and norms over automorphism invariant sets.

Joint work with David Sossa.

O16: On solving fractional SOS convex polynomial optimization problem

Gue Myung Lee

Pukyong National University, Korea

We consider a fractional optimization problem involving SOS convex polynomials, and obtain a linear semidefinite optimization problem by using the Lagrangean dual problem of the problem. We show that we can solve the problem by the linear semidefinite optimization problem. Moreover, we give examples illustrating our main results.

O17: On the nonnegative rank factorization and the completely positive factorization

Nguyen Trung Thanh

National Economics University, Vietnam

Non-negative and completely positive factorizations are types of matrix factorizations with significant applications in data science and related fields. For a nonnegative matrix A, its representation as the sum of r nonnegative rank-one matrices can vary. The minimum such r is known as the nonnegative rank of A, and the corresponding decomposition is called the nonnegative rank factorization of A. Similarly, a symmetric positive semi-definite matrix A can be expressed as $A = BB^T$, where B is a nonnegative matrix. The minimum number of columns p in such a matrix B defines the cp-rank of A, and the corresponding decomposition is called the completely positive factorization of A. Since determining both the nonnegative rank and cp-rank, along with their factorizations, is NP-hard, many studies have formulated these tasks as optimization problems and relied on various heuristic and approximation algorithms to obtain high-quality solutions efficiently. This talk will survey recent progress in computing these factorizations, discussing key challenges and promising computational methods.

O18: A cost-efcient and high-performance framework for diagnosing papillary thyroid carcinoma

Le Hong Phuong

VNU University of Science, Hanoi, Vietnam

This study seeks to automate the multi-class classifcation of papillary thyroid cytopathology using the Bethesda System for Reporting Thyroid Cytopathology. The focus is on improving diagnostic accuracy, interpretability, and computational efciency across three critical diagnostic categories: benign (Bethesda category II), suspicious for malignancy (Bethesda category V), and malignant (Bethesda category VI). We propose a framework consisting of four key components: (1) a novel data augmentation technique designed to improve the model's ability to detect essential features while reducing noise; (2) an enhanced training protocol that mitigates label imbalance by strategically prioritizing specifc records during training cycles; (3) an adaptive model selection process that optimizes the trade-off between classifcation accuracy and computational efciency; and (4) a multi-scale, multi-region analysis approach that integrates information from various regions and magnifcation levels within fne-needle aspiration biopsy images, effectively addressing dataset variability. The baseline model, ThyroidEf Basic, comprising over four million parameters, achieves a macro-average area under the receiver operating characteristic curve (AUC) of 0.9638 and an F1 score of 0.8919. The upgraded model, ThyroidEf Premium, delivers an improved F1 score of 0.8977, albeit with higher computational demands. Model interpretability is enhanced using Gradient-weighted Class Activation Mapping (Grad-CAM), which visually highlights key image regions that drive classifcation decisions. This study presents a reliable, efcient, and interpretable model seamlessly integrated into clinical workflows to provide accurate diagnostic predictions for fneneedle aspiration biopsy slide images. The results highlight the model's robust performance in real-world clinical settings, effectively bridging the gap between automated classifcation systems and practical diagnostic applications.

Joint work with Pham Ngoc Hai, Nguyen Van De.

O19: Recent advances of Bayesian optimization

Tran The Hung

Hanoi University of Science and Technology, Vietnam

Bayesian optimization (BO) has emerged as a mainstream of machine-learning-based provable methods to optimize objective functions that are noisy, derivative-free and expensive to evaluate. BO constructs a surrogate model for the objective function

and quantifes the uncertainty in this model using Gaussian Process regression, a Bayesian machine learning technique. It then employs an acquisition function derived from this surrogate to determine the sampling points. BO has various applications, and is extremely popular for tuning hyperparameters in machine learning algorithms, especially deep neural networks. This talk covers recent advancements in Bayesian optimization and introduces some of our latest results in this feld.

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