INSTITUTE OF MATHEMATICS (VAST)
and
HANOI PEDAGOGICAL UNIVERSITY No. 2

INTERNATIONAL WORKSHOP

"SOME SELECTED PROBLEMS IN PROBABILITY THEORY, GRAPH THEORY, AND SCIENTIFIC COMPUTING"

FEBRUARY 16 - 18, 2017
HANOI – VINH PHUC, VIETNAM

INTERNATIONAL WORKSHOP
"SOME SELECTED PROBLEMS IN PROBABILITY THEORY, GRAPH THEORY, AND SCIENTIFIC COMPUTING"
(February 16-18, 2017, Hanoi – Vinh Phuc, Vietnam)

Aims: Exchange new results and seek possibilities for cooperation in research and teaching.

Organizers

- Institute of Mathematics (Vietnam Academy of Science and Technology), Hanoi, Vietnam
- Department of Mathematics (Hanoi Pedagogical University No. 2), Vinh Phuc, Vietnam
- Department of Applied Mathematics (National Sun Yat-sen University, Kaohsiung, Taiwan)

Sponsors

Vietnam Academy of Science and Technology, Institute of Mathematics (VAST), and Hanoi Pedagogical University No. 2

Organizing Committee

- Prof. Phung Ho Hai, Institute of Mathematics (VAST), Co-Chairman
- Prof. Nguyen Quang Huy, Hanoi Pedagogical University No. 2, Co-Chairman
- Prof. Li-Da Tong, National Sun Yat-sen University, Co-Chairman
- Prof. Phan Thi Ha Duong, Institute of Mathematics (VAST)
- Prof. Dinh Nho Hao, Institute of Mathematics (VAST)
- Dr. Bui Trong Kien, Institute of Mathematics (VAST)
- Prof. Ho Dang Phuc, Institute of Mathematics (VAST)
- Dr. Hoang Ngoc Tuan, Hanoi Pedagogical University No. 2
- Dr. Tran Minh Tuoc, Hanoi Pedagogical University No. 2
- Prof. Nguyen Dong Yen, Institute of Mathematics (VAST)

Coordinators

Prof. Phung Ho Hai, Prof. Nguyen Quang Huy, Prof. Li-Da Tong, Dr. Hoang Ngoc Tuan, Dr. Tran Minh Tuoc, Prof. Nguyen Dong Yen.

PROGRAM

Thursday, 16/02/2017
Institute of Mathematics (VAST), Hanoi
Topics: *Probability Theory and Statistics*

13.30 - 14.00: **Registration**
Institute of Mathematics (VAST), Hanoi

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

14.00 - 14.10: **Opening Ceremony**
Room 301, Institute of Mathematics (VAST), Hanoi

Chair: Prof. Ho Dang Phuc (Institute of Mathematics, VAST)

14.10 - 14.35: Prof. Mei-Hui Guo (National Sun Yat-sen University)
Time Series, Estimation Theory, Stochastic Process
Title of talk: *Robust Principal Expectile Component Analysis*

14.35 - 15.00: Prof. Tran Hung Thao (Institute of Mathematics, VAST)
Stochastic Models
Title of talk: *On Some Fractional Stochastic Liouville Models*

15.00 - 15.25: Prof. May-Ru Chen (National Sun Yat-sen University)
Applied Probability
Title of talk: *An alike U-bike/City-bike system analysis*

15.25 - 15.45: **Tea Break**

Chair: Prof. Tran Hung Thao (Institute of Mathematics, VAST)

15.45 - 16.10: Prof. Ho Dang Phuc (Institute of Mathematics, VAST)
Probability Theory and Statistics
Title of talk: *Stable Probability Distributions and Statistical Application*

16.10 - 16.35: Prof. Hao-Wei Huang (National Sun Yat-sen University)
Operator Theory, Free Probability, and Random Matrix
Title of talk: *Divisibility of Distributions in Bi-free Probability Theory*

16.35 - 17.00: Dr. Can Van Hao (Institute of Mathematics, VAST)
Probability Theory, Stochastic Dynamical Systems
Title of talk: *Contact Process on Random Geometric Graphs*

19.00 - 20.30: **Reception**

Friday, 17/02/2017
Hanoi Pedagogical University No. 2, Xuan Hoa, Phuc Yen, Vinh Phuc
Topics: *Differential Equations, Graph Theory, Optimization*

Chairs: Prof. Nguyen Quang Huy and Dr. Tran Van Bang (Hanoi Pedagogical University No. 2)

09.00 - 09.25: Prof. Hsin-Yuan Huang (National Sun Yat-sen University)
Dynamical Systems, Celestial Mechanics, Partial Differential Equations
Title of talk: *On the Chern-Simons System with Two Higgs Particles*

09.25 - 09.50: Prof. Phan Thi Ha Duong (Institute of Mathematics, VAST)
Discrete Mathematics, Mathematical Foundations of Informatics
Title of talk: *Complex network modelling: Multipartite graphs and random algorithms*

09.50 - 10.15: Prof. Tzon-Tzer Lu (National Sun Yat-sen University)
Matrix Theory, Numerical Analysis, Differential Equations, Discrete Mathematics
Title of talk: *Adomian Decomposition Method for ODEs*

10.15 - 10.45: **Tea Break**

Chair: Dr. Tran Minh Tuoc (Hanoi Pedagogical University No. 2)

10.45 - 11.10: Prof. Ngo Dac Tan (Institute of Mathematics, VAST)
Graph Theory
Title of talk: *On 3-regular digraphs without vertex disjoint cycles of different lengths*

11.10 - 11.35: Prof. Li-Da Tong (National Sun Yat-sen University)
Graph Theory, Interconnection Network
Title of talk: *Hamiltonian Number of a Digraph*

11.35 - 12.00: Dr. Nguyen Van Tuyen (Hanoi Pedagogical University No. 2)
Vector Optimization
Title of talk: *New second-order Karush-Kuhn-Tucker optimality conditions for vector optimization*

12.00 - 13.30: **Lunch**

Chair: Dr. Bui Trong Kien (Institute of Mathematics, VAST)

14.00 - 14.25: Prof. Chieh-Sen Huang (National Sun Yat-sen University)
Numerical Analysis, Partial Differential Equations
Title of talk: *On Implicit Finite Volume WENO Schemes for Convection Diffusion Equation*

14.25 - 14.50: Prof. Dinh Nho Hao (Institute of Mathematics, VAST)
Partial Differential Equations, Scientific Computing
Title of talk: *Reconstruction of the initial condition in parabolic equations*

14.50 - 15.15: Prof. Tsung-Lin Lee (National Sun Yat-sen University)
Numerical Analysis, Algebraic Equations, Scientific Computing
Title of talk: *Mixed cell enumeration in solving polynomial systems*

15.15 - 15.45: **Tea Break**

Chair: Prof. Dinh Nho Hao (Institute of Mathematics, VAST)

15.45 - 16.10: MSc. Tran Hung Cuong (Hanoi University of Industry)
Optimization Methods in Computer Science, Data Clustering
Title of talk: *Qualitative Properties of the Minimum Sum-of-Squares Clustering Problem and Some Incremental Algorithms*

16.10 - 16.35: Prof. Nguyen Dong Yen (Institute of Mathematics, VAST)
Optimization Theory, DC Programming and DCA
Title of talk: *Convergence of a Solution Algorithm in Indefinite Quadratic Programming*

17.30 - 19.00: **Conference Dinner**

Saturday, 18/02/2017
Hanoi City Center

09.00 - 12.00: Excursion
12.00 - 13.30: Lunch

ABSTRACTS

An alike U-bike/City-bike system analysis

May-Ru Chen[1], Shoou-Ren Hsiau[2], Jia-Ching Tsai[2] and Yi-Ching Yao[3]

Abstract: To encourage citizens using bikes as short-distance transit vehicles, many local governments in Taiwan launched the public bike system. One feature of the public bike system is the electronic unmanned management system which provides the rental service: leases at place A and returns at place B. It is very convenient, but sometimes citizens fell in with no bikes when they had arrived rental stations. To reduce this situation, the public bike system needs their employees to rearrange the bikes at some rental stations. An interesting question naturally arises: what is the expectation of the total rental times between two rearrangements in the public bike system? In this talk, we will first give an alike U-bike/City-bike system. Then we consider the corresponding total rental times until a citizen claims that there are no bikes and gave an asymptotic result.

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Qualitative Properties of the Minimum Sum-of-Squares Clustering Problem and Some Incremental Algorithms

Tran Hung Cuong[1], **Jen-Chih Yao**[2], **and Nguyen Dong Yen**[3]

Abstract: In this paper, we will prove some properties of the minimum sum-of-squares clustering problem and some incremental algorithms. Based on the DCA (Difference-of Convex-functions Algorithms), we suggest an improvement of Ordin-Bagirov's algorithm. Preliminary numerical solutions on real-world databases show the efficiency of these algorithms with respect to the standard K-means algorithm.

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Complex network modelling: Multipartite graphs and random algorithms

Phan Thi Ha Duong[1]

Abstract: One of the main challenges in modelling real-world complex networks is to design general models able to reproduce both the heterogeneous degree distribution of these networks and their high local density (clustering coefficient). Many different complex networks can be modeled by graphs, such as system of internet, system of proteins, system of ecology, etc. There is an important approach which aims at generating synthetic complex networks by generating their maximal cliques rather than their edges. The main difficul in this approach is to reproduce correctly the overlaps of the maximal cliques of the graph, which is prevalant in practice. We present here a new graph operator, called the factor graph, which operates in terms of bicliques in a multipartite graph. We address the problem of the termination of the series of graphs obtained by iteratively applying the factor operator starting from a given input graph. We show that the multipartite graph has a very nice combinatorial structure: we exhibit a bijection between its vertices and the chains of the inclusion order on the intersections of the maximal cliques of the original graph.

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Robust Principal Expectile Component Analysis

Meihui Guo[1]
(Jointwork with L.C. Lin[2], R.B. Chen[3] and M.N.L. Huang[4])

Abstract: Principal component analysis (PCA) is widely used in dimensionality reduction for high dimensional data. It finds principal components by sequentially maximizing the component score variance around the mean. However, in many applications, one is interested in capturing the tail variables of the data rather than variation around the center. In order to capture the tail characters, Tran, Osipenko, and Härdle (2014), based on an asymmetric L_2 norm, proposed principle expectile components (PEC). In this study, we introduce a new method called principal Huber-type expectile component (PHEC) using an asymmetric Huber norm to produce robust PECs. Statistical properties of the PHEC are derived and a derivative free optimization approach, particle swarm optimization (PSO), is used to find PHECs. As illustrations, PHEC is applied to real and simulated data with encouraging results.

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Contact process on random geometric graphs

Can Van Hao[1]

Abstract: The contact process is one of the most studied interacting particle systems and is also often interpreted as a model to describe the spread of a virus in a network. In this talk, we study this process on random geometric graphs with large connection radius. In particular, we show that the contact process on these graphs survives a time super-exponential in the number of vertices.

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Reconstruction of the initial condition in parabolic equations

Dinh Nho Hào[1]

Abstract: The prediction of an evolution process requires its initial condition, which is unfortunately not always available in practice and one has to determine it from some indirect observations of the process and then couple it with the dynamical system describing the process for forecasting. This problem is severely ill-posed in the sense that a small perturbation in the observations may course arbitrarily large errors in the solution. We study this problem for processes described by parabolic equations with final time, or boundary or interior observations. We propose variational methods for solving this problem in a stable way. Several numerical examples are presented for showing the efficiency of the approach.

This work has been completed in collaboration with Nguyen Thi Ngoc Oanh (Thai Nguyen University), Phan Xuan Thanh (Hanoi University of Technology and Science), Nguyen Van Duc (University of Vinh).

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On Implicit Finite Volume WENO Schemes for Convection Diffusion Equation

Chieh-Sen Huang[1]

Abstract: The implicit Weighted Essentially Non-Oscillatory (WENO) scheme was proposed by Gottlieb et al. in 2006. They concluded that the success or failure of the flux-implicit WENO depends heavily on the time-discretization used, as well as the numeri- cal problem. The implicit Runge-Kutta time-stepping procedures require the computation of the Runge-Kutta fluxes implicitly. The Runge-Kutta fluxes are the approximation of slopes of the underlying ordinary differential equation along the time axis. However, for hyperbolic conservation laws, Runge-Kutta fluxes involve spatial derivatives. This poses severe CFL constraints on the numerical schemes even for implicit schemes.

We studied schemes with various implicit Runge-Kutta time-stepping procedures coupled with implicit WENO reconstructions. We concluded that the scheme is more stable when Runge-Kutta fluxes are computed only explicitly. For a third order scheme, we accomplish this by replacing the Runge-Kutta fluxes at the end of the time interval with the unknown solutions of the equation at the same time level. Therefore, the only computed Runge-Kutta fluxes are at known time levels and computed explicitly. A natural continuous extension (NCE) of the Runge-Kutta method is then used to achieve third order accuracy in time. However, this NCE-RK approach can not be applied to a convection-diffusion equation, since a second order derivative term is involved. This approach has the similar CFL constraint as an explicit scheme, which is not desired. We circumvent this by reducing the accuracy in time to second order and adopt the Crank-Nicolson time-stepping procedure. In order to make the scheme more desirable, we take the Eulerian-Lagrangian approach. A larger time step is allowed, since the errors along characteristics are small. For problems with small diffusion, we show that the new schemes maintain third order accuracy for smooth tests. The schemes also maintain the essentially non-oscillatory property in the presence of shocks.

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Analytic and combinatorial aspects of bi-freely infinitely divisible laws

Hao-Wei Huang[1]

Abstract: In free probability the notion of free convolution of probability distributions on $\mathbb{R}$ has played an important role since its inception by D. Voiculescu some 30 years ago. In 2013, Voiculescu generalized the notion of free independence to study left and right actions on reduced free product spaces simultaneously, known as bi-free independence. One generalization of the free convolution to the bi-free setting is the bi-free convolution of planar probability distributions. In this talk, we will explain that the bi-freely infinitely divisible laws, and only these laws, can be used to approximate the distributions of sums of identically distributed bi-free pairs of commuting faces. We will also talk about bi-free Lévy-Khintchine representations from an infinitesimal point of view. The proofs depend on the bi-free harmonic analysis machinery that we developed for integral transforms of two variables, and the combinatorics of moments and bi-free cumulants. If time permits, some recent developments in this direction will also be discussed.

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On the Chern-Simons System with Two Higgs Particles

Hsin-Yuan Huang[1]

Abstract: In this talk, I will survey the recent developments of the elliptic system arising from the Chern-Simons Model with two Higgs Particles. Mathematically, the system is a typical skew-symmetric system. Thus, the action functional of this system is indefinite, which makes it difficult to study from the variational method. Among others, I will present my recent works on this system, including the uniqueness of the topological solutions and the radial non-topological solutions, existence of bubbling solutions on a torus and the sharp estimates on the fully bubbling solutions of Liouville type (joint work with X. Han and C.S. Lin, Y. Lee and L. Zhang).

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Mixed cell enumeration in solving polynomial systems

Tsung-Lin Lee[1]

Abstract: Enumerating mixed cells plays a vitally important role in approximating all the isolated zeros of a polynomial system by the polyhedral homotopy continuation method. In this talk I will introduce the relation between them and the basic procedures of the algorithm for enumerating mixed cells. The original approaches are highly serial. Recently we reformulated the original algorithm so that the resulting algorithm can be well adapted in parallel computation.

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Adomian Decomposition Method for ODEs

Yinwei Lin[1], Tzon-Tzer Lu[1] and Cha'o-Kuang Chen[2]

Abstract: We first review the standard Adomian decomposition method to solve differential equations. Normally it has the speed of exponential convergence. But superconvergence occurs sometimes and its speed can reach super-geometric convergence. We will have a few numerical observations to demonstrate this phenomenon.

Then a modified Adomian decomposition method is proposed by using integrating factor. It can solve nonlinear ordinary differential equations of first and second orders where the traditional one fails. A typical example is the Emden–Fowler equation. Nonlinear models are solved by this method to get more reliable and efficient numerical results. Computing experiments obtained from testing our linear and nonlinear problems are far more accurate than those from existing methods. We will also present a complete error analysis with a convergence criterion for this method.

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Stable Probability Distributions and Statistical Application

Ho Dang Phuc[1]

Abstract: It is often argued that financial asset returns are the cumulative outcome of a vast number of pieces of information and individual decisions arriving almost continuously in time. As such, since the pioneering work of Louis Bachelier in 1900, they have been modeled by the Gaussian distribution. The strongest statistical argument for it is based on the Central Limit Theorem, which states that the sum of a large number of independent, identically distributed variables from a finite-variance distribution will tend to be normally distributed. Then, many of the concepts in theoretical and empirical finance developed over the past decades including the classical portfolio theory, the Black-Scholes-Merton option pricing model and the Risk Metrics variance-covariance approach to Value at Risk (VaR) rest upon the assumption that asset returns follow a normal distribution.

However, it has been long known that asset returns are not normally distributed. Rather, the empirical observations exhibit fat tails. In response to the empirical evidence Mandelbrot (1963) and Fama (1965) proposed the stable distribution as an alternative model. Namely, they are supported by the generalized Central Limit Theorem, which states that stable laws are the only possible limit distributions for properly normalized and centered sums of independent, identically distributed random variables. Since stable distributions can accommodate the fat tails and asymmetry, they often give a very good fit to empirical data. In particular, they are valuable models for data sets covering extreme events, like market crashes or natural catastrophes.

A similar circumstances appeared in many other empirical studies. For instance, the uncertainty in the measurements integrated from multiple component errors, usually was be considered as normally distributed by the ordinary Central Limit Theorem. However, the measurement errors not always have normal distribution. Then stable distributions, based on the generalized Central Limit Theorem, are the most suitable alternatives.

Hence, we devote this talk to presentation of some recent results related to stable probability distributions. The first part provides a better understanding of the features and characteristics of stable and semi-stable probability distributions on convex cone, an abstract algebraic structure more general than linear spaces. Some results also characterize the stability of random measures, the relationship between stability with regular variation of random measures.

The second part provides results of using the theory of stable probability distribution in handling statistical data of GPS navigation signals. By Kolmogorov - Smirnov hypothesis test, it showed the errors in GPS navigation signals are not normally distributed, but have stable distribution with stability index less than 2.

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On 3-regular digraphs without vertex disjoint cycles of different lengths

Ngo Dac Tan[1]

Abstract: We raise the conjecture that for every integer $g \geq 3$ there are only finitely many 3-regular digraphs of girth g without vertex disjoint directed cycles of different lengths and give support for this conjecture by proving that it is true for $g = 3$.

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On Some Fractional Stochastic Liouville Models

Tran Hung Thao[1]

Abstract: An approximate approach to fractional Liouville models is introduced based on a fundamental result on L^2-approximation of a fractional Brownian motion of Liouville form. As applications we consider some models as fractional geometric Brownian motion, fractional Ornstein-Uhlenbeck, fractional mean-reversion process, fractional volatility

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Hamiltonian Number of a Digraph

Li-Da Tong[1]

Abstract: A hamiltonian walk in a digraph is a closed spanning directed walk with minimum length in the digraph. The length of a hamiltonian walk of a digraph D is called the hamiltonian number of D, denoted by $h(D)$. A digraph D of order n is hamiltonian if $h(D) = n$. For a general digraph D, the determining of D being hamiltonian or not is an NP-complete problem. In this talk, we will discuss the hamiltonian numbers in digraphs and related problems.

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New Second-Order Karush–Kuhn–Tucker Optimality Conditions for Vector Optimization

Nguyen Quang Huy[1], **Do Sang Kim**[2], **and Nguyen Van Tuyen**[3]

Abstract: In this talk, we focus on the vector optimization problems with constraints, where objective functions and constrained functions are Fréchet differentiable, and whose gradient mapping is locally Lipschitz. By using the second-order symmetric subdifferential and the second-order tangent set, we introduce some new types of second-order regularity conditions in the sense of Abadie. Then we establish some second-order necessary optimality conditions Karush–Kuhn–Tucker-type for local efficient (weak efficient, Geoffrion properly efficient) solutions of the considered problem. In addition, we provide some sufficient conditions for a local efficient solution to such problem.

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Convergence of a Solution Algorithm in Indefinite Quadratic Programming

Tran Hung Cuong[1], Yongdo Lim[2], and Nguyen Dong Yen[3]

Abstract: It is proved that, for an indefinite quadratic programming problem under linear constraints, any iterative sequence generated by the *Proximal DC decomposition algorithm* R-linearly converges to a Karush-Kuhn-Tucker point, provided that the problem has a solution. Another major result of this paper says that DCA sequences generated by the algorithm converge to a locally unique solution of the problem if the initial points are taken from a suitably-chosen neighborhood of it. To deal with the implicitly defined iterative sequences, a local error bound for affine variational inequalities and novel techniques are used. Numerical results together with an analysis of the influence of the decomposition parameter, as well as a comparison between the Proximal DC decomposition algorithm and the *Projection DC decomposition algorithm*, are given in this paper.

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