6TH NUS GRADUATE SYMPOSIUM IN MATHEMATICS

23 April 2018 (Monday)
Department of Mathematics
S17 #04-05 & #04-06

NUS GRADUATE SYMPOSIUM IN MATHEMATICS
23 April 2018, Department of Mathematics, NUS

PROGRAMME

Time/Venue	S17-04-06	S17-04-05
08:50 – 09:00	**Opening Address** Prof ZHU Chengbo	
09:00 – 09:45	**Deciding Parity Games in Quasipolynomial Time** Prof Frank STEPHAN *p2*	
09:45 – 10:15	*Tea break @ Mathematics Department Lounge*	
10:15 – 11:00	**Toward blind image deconvolution: models and techniques** A/Prof JI Hui *p2*	
11:00 – 11:20	CUI Hanwen *p2*	DAO Van Thinh *p3*
11:20 – 11:40	XI Guojiang *p3*	LI Ning *p3*
11:40 – 12:00	ZHANG Teng *p3*	WU Chengyuan *p4*
12:00 – 14:00	*Lunch @ Mathematics Department Lounge*	
14:00 – 14:20	LAM Xin Yee *p4*	WU Bin *p4*
14:20 – 14:40	ZHANG Yangjing *p4*	QING Huan *p4*
14:40 – 15:00	YUAN Yancheng *p5*	Birzhan MOLDAGALIYEV *p5*
15:00 – 15:20	PANG Tongyao *p5*	
15:20 – 15:50	*Tea break @ Mathematics Department Lounge*	
15:50 – 16:10	YANG Liuge *p6*	TEO Yi Han *p6*
16:10 – 16:30	YANG Ziyi *p6*	MADE Tantrawan *p6*
16:30 – 16:50	GUAN Yu *p6*	Andrew Ernest HENDRICKSON *p7*
16:50 – 17:10	QIAN Lilong *p7*	

(Number in italic denotes page number of abstract)

ABSTRACTS

Prof Frank STEPHAN
Deciding Parity Games in Quasipolynomial Time

It is shown that the parity game can be solved in quasipolynomial time. The parameterised parity game -- with n nodes and m distinct values -- is proven to be in the class of fixed parameter tractable (FPT) problems when parameterised over m. Both results improve known bounds, from runtime n^{O(sqrtn)} to O(n^{log(m)+6}) and from an XP-algorithm with runtime n^{m/3+O(1)} for fixed parameter m to an FPT-algorithm with runtime O(n^5)+g(m), for some function g depending on m only. As an application it is proven that coloured Muller games with n nodes and m colours can be decided in time O((m^m * n)^5); it is also shown that this bound cannot be improved to 2^{o(m * \log(m))} * Poly(n) unless FPT = W[1]. Further investigations deal with memoryless Muller games and multi-dimensional parity games.

A/Prof JI Hui
Toward blind image deconvolution: models and techniques

Blind Image de-convolution is one challenging inverse problem with many applications in practice. Blind deconvolution aims at recovering the clear image from its blurred observation without knowing how it is blurred. In many realistic scenarios, the blurring process is non-stationary in the sense that different image regions are blurred by different kernels, which makes it even more difficult. In this talk, I will present several mathematical models and techniques toward solving blind image deblurring problems arising from industrial imaging and digital photography, including blind motion deblurring and out-of-focus deblurring.

CUI Hanwen
Moving contact line on a deformable substrate: A 1-D illustration

The classical moving contact line problem is defined with two immiscible fluids flowing on a solid substrate. One of its crucial generalizations goes to the deformable-substrate case, where the original solid substrate will now be modeled by elasticity.

This deformable-substrate generalization is more than a branch of the classical moving contact line problem. It may provide a closer look at the nature of the moving contact line, as all materials are more or less deformable. It is also an add-on for the fluid-structure interaction problem, which generalizes the original single-phase-fluid case to the two-phase-fluid one.

This informal talk reduces the model to a textbook-level one-dimensional example, with a clear interpretation of how the model has been derived and how its simulations have been carried out.

DAO Van Thinh
Arithmetic property of even hyperelliptic curves over function fields

In this talk, I am going to compute the average size of 2-Selmer groups of families of even hyperelliptic curves over function fields. The result will be obtained by a geometric method which is based on a Vinberg's representation of the group G= PSO (2n+2) and Hitchin fibration. Their relation helps us to connect the size of 2-Selmer groups and the number of rational points on Hitchin fibers, where the latter are more accessible by using the canonical reduction theory of G-bundles.

XI Guojiang
Numerical study of the wetting transition modeled by Cahn-Hilliard equation

Droplets on a solid surface patterned with microstructures can exhibit the composite Cassie-Baxter(CB) state or the wetted Wenzel state. The transition from the CB state to the Wenzel state is called wetting transition. The liquid-vapor coexistence is modeled by Cahn-Hilliard equation. We study the wetting transition by extending the climbing string method to generalized gradient system. We compute the transition states and energy barriers for a three-dimensional droplet on patterned surfaces.

LI Ning
Generalized Whittaker models and theta lift of nilpotent orbits

The orbit method is developed by Kirillov to build up a bridge between coadjoint orbits and irreducible unitary representations of a nilpotent Lie group. However, this philosophy can be put in a much more general setting. For a smooth representation π of a reductive group over a characteristic 0 local field, it is believed there's a deep connection between the space of generalized Whittaker models of π and the wave front cycle (defined by Harish-Chandra in the non-Archimedean case and by Howe and Barbasch-Vogan in the Archimedean case) attached to π. For non-Archimedean case, Mœglin and Waldspurger prove the dimension of the space of generalized Whittaker models attached to a nilpotent orbit equals the multiplicity of the orbit in the wave front cycle. For Archimedean case, the wave front cycle is related to associated cycle (defined by Vogan) via Kostant-Sekiguchi correspondence. In this talk, we describe the relationship between generalized Whittaker models of $\check{\pi}$ and $\Theta(\pi)$ using moment map.

ZHANG Teng
Numerical simulations of vortex interactions in the NLSE with periodic boundary condition

Quantum vortex is an interesting phenomenon in superfluid and superconductors. And the nonlinear Schrödinger equation (NLSE) is a fundamental model to understand the motion of quantum vortices. Recently I have done some numerical simulations of vortex interactions in the 2-dimensional NLSE with periodic boundary condition. In this talk, I will show some numerical results of my work, including initial setups, comparison with theoretical predictions, and several attractive motion patterns.

WU Chengyuan
Weighted Persistent Homology and Bockstein Spectral Sequence

Persistent homology is a recent branch of topology that has many applications. It is also used in topological data analysis. We give an introduction to persistent homology and some of its applications. We also discuss our recent research on weighted persistent homology and the Bockstein Spectral Sequence

This is a joint work with Shiquan Ren and Prof Jie Wu.

LAM Xin Yee
Some review on interior-point methods for block-angular problems

Block-angular-structured constraints appear in many real-world optimization problems, where decision variables and constraints can be grouped in different blocks which are dependent due to some linking constraints. In this talk, we will study some interior-point methods for solving these specialized problems. The study will be mainly base on the paper by Castro and Stefano (2016), and Castro (2015).

WU Bin
On Large Games with Bio-social Traits

This paper shows that, in a class of large games with traits model, distinguish agent space and trait space is not only sufficient but also necessary for the existence of pure strategy Nash equilibrium and closed graph property.

ZHANG Yangjing
An efficient Hessian based algorithm for solving large-scale sparse group Lasso problems

The sparse group Lasso is a widely used statistical model which encourages the sparsity both on a group and within the group level. In this paper, we develop an efficient augmented Lagrangian method for large-scale non-overlapping sparse group Lasso problems with each subproblem being solved by a superlinearly convergent inexact semismooth Newton method. Theoretically, we prove that, if the penalty parameter is chosen sufficiently large, the augmented Lagrangian method converges globally at an arbitrarily fast linear rate for the primal iterative sequence, the dual infeasibility, and the duality gap of the primal and dual objective functions. Computationally, we derive explicitly the generalized Jacobian of the proximal mapping associated with the sparse group Lasso regularizer and exploit fully the underlying second order sparsity through the semismooth Newton method. The efficiency and robustness of our proposed algorithm are demonstrated by numerical experiments on both the synthetic and real data sets.

QING Huan
Community Detection by SCORE-Anorm

Consider a network where the nodes split into K different communities. The community labels for the nodes are unknown and it is of major interest to estimate them. We propose a new approach to community detection which we call SCORE-Anorm: let A be the adjacency matrix of the network. We find that applying SCORE algorithm to the normalized matrix of A can find community labels. Here we give the reason why SCORE-Anorm method can do community detection.

YUAN Yancheng
Clustering: Efficient Algorithm and More

Clustering may be the most fundamental problem in unsupervised learning which is still active in machine learning research because of its importance in many applications. Popular methods like K-means may suffer from instability, as they are prone to get stuck in its local minima. Recently, the sum-of-norms (SON) model (also known as clustering path), which is a convex relaxation of hierarchical clustering model, has been proposed in Lindsten, F., Ohlsson, H., & Ljung, L. (2011, June) and Hocking, T. D., Joulin, A., Bach, F., & Vert, J. P. (2011, June). Although numerical algorithms like ADMM and AMA are proposed to solve convex clustering model (Chi, E. C., & Lange, K., 2015), it is known to be very challenging to solve large-scale problems. In this paper, we propose a semi-smooth Newton based augmented Lagrangian method for large-scale convex clustering problems. Extensive numerical experiments on both simulated and real data demonstrate that our algorithm is highly efficient and robust for solving large-scale problems. Moreover, the numerical results also show the superior performance and scalability of our algorithm compared to existing first-order methods.

Birzhan MOLDAGALIYEV
Randomness through Computation

What can we learn about randomness through computation? In this talk, I am going to introduce basic ideas behind theory of Algorithmic Randomness, a study of pseudorandomness using ideas from Computability Theory. The definitions from Algorithmic Randomness try to capture the intuitive notion of randomness via various methods such as randomness tests, martingales and compact descriptions. I will go through some of these definitions.

PANG Tongyao
Image restoration with Poisson and Poisson-Gaussian mixture noise

A typical model for image restoration problem consists of two terms, the fidelity term and the penalty term. The former one is usually designed according to the noise statistics, for example, the well-known least square fidelity for Gaussian noise and Kullback-Leibler(KL)-divergence fidelity for Poisson noise. However, the noise in reality is always much more complicated than single Gaussian or Poisson noise, which makes it difficult to design an appropriate fidelity term according to the noise statistics. Recently, a universal l1 + l2 fidelity term was proposed for mixed noise and achieved a quite good numerical performance. However, the statistical meaning behind their model remains unclear and it takes a lot of effort to tune the parameters manually for different images and problems. Consequently, our approach is developed to overcome these drawbacks.

YANG Liuge
Blind Image Deconvolution

This talk will introduce a new algorithm to solve the problem of blind image deconvolution. For each iteration in this algorithm, it first makes use of ringing effect followed by the Canny Edge Detection to better locate the positions of image edges. Then, this information is combined with the L_2 regularization on image gradients to get an intermediate estimate of clear image, which will be used to estimate the uniform blur kernel in the next step. Finally, the estimation of the ground truth image for this iteration is obtained by solving a non-blind deconvolution problem with the kernel estimated before.

TEO Yi Han
Branes in the Higgs moduli space of a compact Riemann surface

We will first be introduced to the idea of a Kähler manifold, and its interesting submanifolds: the complex and Lagrangian ones. A hyperkähler manifold is a smooth manifold equipped with three Kähler structures satisfying the quantionic relations. Next, we will define Higgs bundles over a compact Riemann surface, and see that the moduli space of Higgs bundle is a hyperkähler manifold. Finally, we will discuss the various branes in a Higgs moduli space; submanifolds that are complex with respect to a Kähler structure, and Lagrangian with respect to another.

YANG Ziyi
Extracting Particles from Cryo-EM Micrographs

Single particle reconstruction (SPR) using cryogenic electron microscopy (cryo-EM) is a rapidly advancing technique for determining the structure of biological macromolecules at near-atomic resolution. The first step in the computational pipeline of SPR is to extract single particle images from multiple cryo-EM micrographs. Automating the process of particle image extraction will be helpful. In this talk, I will discuss the difficulties of such detection task and present some of the state of the art algorithms for general object detection.

Made TANTRAWAN
A Note on Closedness of Convex Sets in Banach Function Spaces

Let X be a Banach function space endowed with a locally convex topology τ. A set in X is said to be order closed if it is closed with respect to dominated convergence of sequence of functions. A well-known problem arising from theory of risk measures in financial mathematics ask whether order closedness of a convex set in X characterizes closedness with respect to the topology τ. In this talk, I will give an introduction to this problem, and show some recent results.

GUAN Yu
Best Rank-1 Approximation of a Tensor Using SVD

This paper revisits the classical problem of finding the best rank-1 approximation to a generic tensor. The focus is on providing a mathematical proof for the convergence of the iterates of an SVD-based algorithm. In contrast to the conventional approach by the so-called alternating least squares (ALS) method that works to adjust one factor a time, the SVD-based algorithms improves two factors simultaneously. The ALS method is easy to implement, but suffers from slow convergence and easy stagnation at a local solution. It has been suggested recently that the SVD-algorithm might have a better limiting behavior leading to better approximations, yet a theory of

convergence has been elusive in the literature. This note proposes a simple tactics to close that gap.

Andrew Ernest HENDRICKSON
An Introduction to Arthur's Conjecture

I will give a brief introduction to Arthur's conjecture on the discrete spectrum L2disc (G(Q)\G(A)) of a reductive linear algebraic group G defined over Q. According to the conjecture, the irreducible constituents of L2disc can be partitioned into equivalence classes called A-packets, which I will describe.

QIAN Lilong
Separability of Multipartite SSPPT Quantum States

We extend the conception of strong positive partial transpose (SPPT) to the multipartite case. It has been studied in the tripartite quantum systems in Yu Xin-Yu and Zhao Hui's paper, however it does not inherit the PPT property in the multipartite system i.e. it is not PPT under any partial transpose. And it require additional conditions for the super SPPT (SSPPT) state being separable. Hence we provide a new idea of generalizing the SPPT state in multipartite system which would be more natural and preserves the PPT property. Moreover some sufficient conditions for SPPT being separable are also given.