5th SIAM Student Chapter@NUS Symposium on Applied and Computational Math

- **Date and location:** Feb 23th, 2016; S17-04-06 (Seminar Room 1), Department of Mathematics, Faculty of Science, National University of Singapore.

- **Sponsor:** Society of Industrial and Applied Mathematics (SIAM), National University of Singapore (NUS).

- **Committee:** Bao Weizhu (advisor); Ruan Xinran (president); Li Yunzhi (vice president); Guo Han (secretary).

- **Description:** A one-day symposium on industrial and applied mathematics, including 2 plenary talks given by Prof. Feng Jiashi (from Department of Electrical and Computer Engineering) and Prof. Vincent Tan Yan Fu (from Department of Electrical and Computer Engineering and Mathematics) and 8 talks given by research fellows in related areas. Lunch will be provided.

All are welcome!

SIAM
Society for Industrial and Applied Mathematics

NUS
National University of Singapore

Programme

Venue: S17-04-06 (Seminar Room 1)

09:20 - 09:30	**Opening remarks**
09:30 - 10:20	**Plenary talk by Prof. Feng Jiashi**
10:20 - 11:00	**Plenary talk by Prof. Vincent Tan Yan Fu**
11:00 - 11:30	**Talk 3 by Zhang Xiaowei**
11:30 - 12:00	**Talk 4 by Cui Ying**
12:00 - 13:30	**Group photo & Lunch**
13:30 - 14:00	**Talk 5 by Bao Chenglong**
14:00 - 14:30	**Talk 6 by Yang Chen**
14:30 - 15:00	**Talk 7 by Yu Jinjiong**
15:00 - 15:30	**Tea break**
15:30 - 16:00	**Talk 8 by Li Yunzhi**
16:00 - 16:30	**Talk 9 by Wang Yan**
16:30 - 17:00	**Talk 10 by Zhao Quan**

Title and abstract

- **Plenary talk 1: 09:30 - 10:20**
  - Speaker: Prof. Feng Jiashi
  - Title: Big Visual Data Analysis: A Machine Learning Perspective
  - Abstract: The explosive growth of visual data scale has presented great challenges to computer vision, demanding methods to handle large-scale, unlabelled and noisy data. In this talk, I will view these challenges through the lens of machine learning, and discuss how to design sample-efficient and robust learning methods for big visual data analysis. My first example illustrates how to transfer useful knowledge among a few labeled data and (unlimited) unlabelled data through visual attribute learning as well as the application in deep learning. The second example introduces robust classification methods that deal with various noise in realistic visual data and explains how to scale up the methods to big data. As concrete applications, our results significantly improve large-scale visual object recognition results in settings where state-of-the-art methods fail. Motivated by good empirical results, we provide a detailed theoretical analysis and identify practically relevant properties that affect the quality of visual data analysis.

- **Plenary talk 2: 10:20 - 11:00**
  - Speaker: Prof. Vincent Tan Yan Fu
  - Title: On some variations of the Gärtner-Ellis theorem with applications to information theory
  - Abstract: I will talk about the Gärtner-Ellis theorem, a result in the theory of large deviations. I will only consider "tail" events for the form $X_n > x$. If the sequence of cumulant generating functions and the normalizing speed satisfy a certain property, I show that we can prove the lower bounds of the probabilities (the difficult part) using ideas from weak convergence, which is a departure from the usual technique based on change-of-measure. This has applications to erasure decoding in information theory.

- **Talk 3: 11:00 - 11:30**
  - Speaker: Dr. Zhang Xiaowei
  - Title: Incremental Regularized Least Squares for Dimensionality Reduction of Large-Scale Data
  - Abstract: Over the past few decades, much attention has been drawn to large-scale incremental data analysis, where researchers are faced with huge amount of high-dimensional data acquired incrementally. In such a case, conventional algorithms that compute the result from scratch whenever a new sample comes are highly inefficient. To handle this problem, we propose a new incremental algorithm IRLS that incrementally computes the solution to the regularized least squares (RLS) problem with multiple columns on the right-hand side. More specifically, for aRLS problem with c ($c > 1$) columns on the right-hand side, we update its unique solution by solving a RLS problem with single column on the right-hand side whenever a new sample arrives, instead of solving a RLS problem with columns on the right-hand side

from scratch. As an application, we apply the newly proposed IRLS to supervised dimensionality reduction of large-scale data and focus on linear discriminant analysis (LDA). We first propose a new batch LDA model that is closely related to RLS problem, and then apply IRLS to develop a new incremental LDA algorithm. Experimental results on real-world datasets demonstrate the effectiveness and efficiency of our algorithms.

- **Talk 4: 11:30 - 12:00**

  - Speaker: Cui Ying
  - Title: An inexact accelerated block coordinate descent method for multi-block unconstrained problems
  - Abstract: In this talk, we present a two-block inexact majorized accelerated block coordinate descent method for solving problems without joint constraints. This framework can be used to solve the dual of the composite least square problems. For solving subproblems, we adopt the inexact one cycle symmetric Gauss-Seidel technique and a hybrid of the semismooth Newton-CG method and the accelerated proximal gradient method. The incorporation of the second order information plays a pivotal role in making our algorithms and the other existing ones more efficient. Numerical results demonstrate that our proposed methods outperform, by a large margin, existing different variants of the block coordinate descent methods.

- **Talk 5: 13:30 - 14:00**

  - Speaker: Dr. Bao Chenglong
  - Title: Proximal alternating algorithms in dictionary learning
  - Abstract: In recent years, sparse coding has been widely used in many applications ranging from image processing to pattern recognition. Most existing sparse coding based applications require solving a class of challenging non-smooth and non-convex optimisation problems. Despite the fact that many numerical methods have been developed for solving these problems, it remains an open problem to find a numerical method which is not only empirically fast, but also has mathematically guaranteed strong convergence. In this talk, I will review some proximal alternating algorithms for solving such problem and give rigorous convergence analysis. Experiments show that the proposed method achieves similar results with less computation when compared to widely used methods such as K-SVD.

- **Talk 6: 14:00 - 14:30**

  - Speaker: Yang Chen
  - Title: Feynman-Kac Representation for Periodic Problems
  - Abstract: We establish a Feynman-Kac type representation for the solutions to a class of periodic parabolic terminal-boundary value problems, whose terminal and boundary conditions depend on the unknown function itself. In particular, the solution to the periodic problem is represented as the expectation of the time integral of functionals of a diffusion process with periodic interventions at first passage times, which can be interpreted as the expected present value of a perpetual stochastic cash flow with periodic continuous and discrete payments. As an application in finance, we discuss the pricing of the dual- purpose fund, a recently popular structured mutual

fund in China. Our representation result provides a rigorous mathematical characterization of the fund's value in terms of a periodic PDE, as well as an efficient numerical evaluation procedure. Our results suggest that the capital shares of the dual-purpose fund in China are overpriced by the market, which agrees with the findings in the literature.

- **Talk 7: 14:30 - 15:00**
  - Speaker: Yu Jinjiong
  - Title: Edwards-Wilkinson Fluctuations in the Howitt-Warren flows
  - Abstract: We study current fluctuations in a one-dimensional interacting particle system known as the dual smoothing process that is dual to random motions in a Howitt-Warren flow. The Howitt-Warren flow can be regarded as the transition kernels of a random motion in a continuous space-time random environment. It turns out that the current fluctuations of the dual smoothing process fall in the Edwards-Wilkinson universality class, where the fluctuations occur on the scale $t^{1/4}$ and the limit is a universal Gaussian process.

- **Talk 8: 15:30 - 16:00**
  - Speaker: Li Yunzhi
  - Title: Numerical Study of Vapor Condensation and Wetting Transition on Patterned Surface using String Method
  - Abstract: In the first part, we study vapor condensation on hydrophobic surfaces patterned with microscale pillars. The critical nuclei, the activation barriers, and the minimum energy paths are computed using the climbing string method. In the second part, we study wetting transition on hydrophobic grooved surface using molecular dynamics. We use density field of particles as the collective variables. Then we apply climbing string method to find out the transition state in the space of collective variables.

- **Talk 9: 16:00 - 16:30**
  - Speaker: Wang Yan
  - Title: Solid-state dewetting of thin films on rigid curved substrates
  - Abstract: Employing a thermodynamic variational method, we propose a sharp interface model combined with a relaxed contact angle boundary condition for simulating solid-state dewetting of thin films on rigid curved substrates. In this model, film/vapor interfacial anisotropy is easily included, and the movement of the contact line can be explicitly described by the relaxed boundary condition. We implement the model by a semi-implicit parametric finite element method to study the equilibrium configuration and the migration of small islands and the pinch-off of large islands. We also apply the model to simulate the template-assisted solid-state dewetting on inverted pyramidal pits. The simulation results presented in the paper capture many of the complexities associated with solid-state dewetting experiments.

- **Talk 10: 16:30 - 17:00**
  - Speaker: Zhao Quan

- Title: A Parametric Finite Element Method for Simulating Solid-State Dewetting Problems
- Abstract: We propose an efficient and accurate parametric finite element method (PFEM) for solving the sharp interface model of solid-state dewetting of thin films with anisotropic surface energies. The governing equations of the sharp interface model belong to high-order geometric PDEs, which include anisotropic surface diffusion flow and contact line migration. Compared to the traditional methods, the proposed PFEM not only has good accuracy, but also poses very mild restrictions on the numerical stability.