IAM – PIMS
2003-2004 DISTINGUISHED COLLOQUIUM SERIES

The Institute of Applied Mathematics (IAM) and the Pacific Institute of Mathematical Sciences (PIMS) at the University of British Columbia are pleased to announce their 7th Annual Distinguished Colloquium Series.

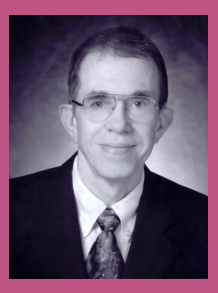
The talks are free and are held in room 301 of the Leonard S. Klinck Building (6356 Agricultural Road, UBC) from 3:00 to 4:00 pm on Mondays. Coffee and snacks are served in room 306, about 20 minutes before the talks.

Jorge Nocedal

22 September, 2003: JORGE NOCEDAL – Dept. of Electrical & Computer Engineering, Northwestern University

The New Faces of Nonlinear Optimization

In the last few years it has been shown that nonlinear optimization methods are successful at solving problems in two important areas of application. The first concerns models with equilibrium constraints which arise in robotics, economics and network design. The second area concerns the optimization of systems described by partial differential equations, and includes many optimal control, parameter identification and inverse problems. This talk provides an overview of these two emerging areas. We will present case studies involving network design, weather forecasting and the design of nano-controllers. We discuss breakthroughs in nonlinear programming that have made these advances possible, as well as the challenges that will arise as we ask current optimization software to solve larger and larger problems.



Harry Swinney

6 October, 2003: HARRY SWINNEY – Department of Physics, University of Texas at Austin

Spatial Patterns and Shock Waves in Sand

Granular media such as sand and cereal are mixed and poured in many processes, yet granular media remain less well understood than fluids and solids. We conduct experiments on the dynamics of granular media and compare the observations to particle and continuum models. Our experiments on vertically oscillating granular layers yield spatial patterns – stripes, squares, hexagons, spirals, and localized structures ("oscillons"). A detailed study of the square patterns reveals behavior surprisingly similar to a crystal lattice that can form defects and melt. In experiments on granular flow past an obstacle, shock waves are found to form for common conditions (e.g., pouring sugar into a spoon). The various measurements will be compared with molecular dynamics simulations and simulations of Navier-Stokes-like continuum equations.

Chris Bretherton

3 November, 2003: CHRIS BRETHERTON – Department of Atmospheric Science, University of Washington

Understanding the Circulation of the Tropical Atmosphere Using Simple Mathematical Models

Numerical weather prediction and climate models have more difficulty in correctly simulating the large-scale atmospheric circulation in the tropical atmosphere than in mid-latitudes. One reason is that Earth's rotation, which gives mid-latitude storms and the jet stream their characteristics, has more subtle effects in the tropics. A second reason is the importance of highly localized and intermittent internal heating, e.g. latent heating from rainfall released in thunderstorm systems, in the tropics. We discuss simple new models of tropical atmospheric circulations that couple the internal heating to the circulation and capitalize on the weakness of the effects of Earth's rotation in this region, and discuss how such models can provide insights into tropical climate and climate change.

Andrea Bertozzi

19 January, 2004: ANDREA BERTOZZI – Department of Mathematics, University of California Los Angeles

Higher-Order PDEs in Fluid Dynamics and Image Processing

Higher-order PDEs are making an impact in a number of research areas in engineering and physics. Thin film fluids arise in both biological and engineering applications. In these problems, surface tension and surface chemistry are very important. Image processing is another area in which nonlinear PDEs have made a large impact in the last ten years. I will talk about some applied mathematics problems related to these areas in which fourth-order nonlinear PDEs play an important role. Current research in this area bridges analysis, numerical analysis, scientific computing and modeling.

Marco Avellaneda

23 February, 2004: MARCO AVELLANEDA – Courant Institute of Mathematical Sciences, New York University

Reconstructing Volatility

We develop a formula for calculating the implied volatility of index options based on the volatility skews of the options on the underlying stocks and on a given correlation matrix for the basket. The derivation uses the steepest-descent approximation for evaluating the multivariate probability distribution function for forward stock prices. A simple financial justification of the formula is provided. We apply the formula to the computation of the implied volatilities of liquidly-traded options on two exchange-traded funds (ETFs) and find that the theoretical results are in very good agreement with contemporaneous marketmaker quotes from CBOE and AMEX. On a more general note, this talk will showcase applications of the Steepest Descent Approximation method to other situations involving relative-value volatility trading.

Stephen Boyd

15 March, 2004: STEPHEN BOYD – Department of Electrical Engineering, Stanford University

Recent Advances in Convex Optimization

In this talk I will give an overview of some recent developments in convex optimization, a special type of optimization problem. The basic idea is that convex optimization problems, even ones that are large-scale, nonlinear, and nondifferentiable, are fundamentally tractable; in particular, interior-point methods originally developed in the 1980s for linear programming solve many convex optimization problems very efficiently. The second development is the discovery, over the last ten years or so, of many applications in areas like control theory, signal processing, communications and networks, circuit design, data analysis, and finance.

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