THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

GEORGE MASON UNIVERSITY

WILLIAM & MARY

Undergraduate Research Conference

George Mason University
April 6, 2013

About the conference

The Undergraduate Mathematics Conference in Washington is aimed at providing an opportunity for undergraduate mathematics students to meet their peers, to exchange their research experiences, and to interact with other professionals in the field. This is a one-day event with presentations from students, a keynote lecture, panel discussions on careers, and a lot of opportunities to interact with other workshop participants.

The conference series started in April 2012. It is also closely related to the CSUMS workshops organized by both the College of William and Mary and George Mason University in previous years. Support for this conference is provided by the College of William and Mary, George Mason University, the George Washington University, and the NSF grant DMS-0846477 through the MAA Regional Undergraduate Mathematics Conferences program: http://www.maa.org/RUMC/.

Organizers:

From GMU: Maria Emelianenko and Tim Sauer

From CWM: Chi-Kwong Li and Junping Shi

From GWU: Svetlana Roudenko and Yongwu Rong

Keynote Address #1

Dr. Michelle Girvan
"Modeling the Dynamics of Gene Networks''

Michelle Girvan is an Assistant Professor in the Department of Physics at the University of Maryland, College Park (UMCP). She is also a member of both UMCP's Applied Mathematics and Scientific Computing program and the Santa Fe Institute's external faculty. Her research operates at the intersection of statistical physics, applied mathematics, and computer science and has applications to social, biological, and technological systems. More specifically, Dr. Girvan's work focuses on complex networks and often falls within the fields of computational biology and sociophysics.

Dr. Girvan received her Ph.D. in physics from Cornell University in 2004, where she worked on using statistical physics and nonlinear dynamics to understand the structure and function of complex networks. Before starting her faculty position at Maryland, she was a postdoctoral fellow at the Santa Fe Institute where she studied robustness and fragility in complex networks.

Abstract:
The complex process of genetic control relies upon an elaborate network of interactions between genes. Our goal is to use simple mathematical models to understand the role of network structure in gene regulation. Here, we focus on Boolean systems, which have received extensive attention as useful models for genetic control.   An important aspect of Boolean network models is the stability of their dynamics in response to small perturbations. Previous approaches to stability have assumed uncorrelated random network structure. Real gene networks typically have nontrivial topology significantly different from the random network paradigm. To address such situations, we present a general method for determining the stability of large networks of any specified network topology and predicting their steady-state behavior in response to small perturbations. Additionally, we generalize to the case where individual genes have a distribution of "expression biases," and we consider a nonsynchronous update, as well as extension of our method to non-Boolean models in which there are more than two possible gene states. We find that stability is governed by the maximum eigenvalue of a modified adjacency matrix, and we test this result by comparison with numerical simulations. We also discuss the possible application of our work to experimentally inferred gene networks, and propose that a dynamical instability in the gene regulatory network may be a causal mechanism associated with some cancers.

Keynote Address #2

Dr. Kathryn Brenan
"Reflections of an applied mathematician: Formulas for success at the Aerospace Corporation"

I am currently a Senior Project Engineer in the Imagery Programs Division at The Aerospace Corporation. My research & work projects have involved the development of numerical algorithms for signal & image processing applications and for differential-algebraic equations arising in trajectory optimal control problems. In the last couple years, my interests have broadened to include Monte Carlo simulations and data analysis. My work has required a solid understanding of numerical linear algebra, numerical integration, and optimization methods.

I received my PHD in Applied Mathematics & Numerical Analysis from UCLA.
I am a co-author of the book, "Numerical Solution of Initial-Value Problems in Differential-Algebraic Equations." Over the years, I have strived to stay involved in SIAM in a variety of ways, including serving on the Board of Trustees and the Council, by giving talks on my work and organizing mini-symposia for SIAM conferences, and by engaging in mentoring events, conferences, and by engaging in mentoring events.

Abstract:
My career as an industrial mathematician has been shaped by my work at The Aerospace Corporation, which operates a nonprofit Federally Funded Research and Development Center for the U.S. government. I have strived to solve real-world problems of interest to my customers in the defense and national security arenas thru the development and application of numerical algorithms.

In my talk I will describe a particular image processing algorithm I found fascinating from the point of view of the mathematics it utilizes. A basic knowledge of linear algebra, discrete fast Fourier transforms, and iterative algorithms is sufficient background for this talk. I will conclude my talk with a discussion on my work environment, and how it compares to working in academia.

Career Panel

This informal discussion will focus on various career paths mathematicians can choose to pursue in academia, industry or national labs, and especially on challenges/special attributes associated with each. Each participant will share his/her experience and give advice to younger members of the audience. Questions from the audience will be solicited and are highly encouraged.

Panel Participants:

- o Leah Marshall (Census Bureau)
- o Yongwu Rong (George Washington University)
- o Michael Steuerwalt (National Science Foundation)
- o Arjun Sanghvi (National Institute of Health)

Conference Schedule

- 9:00 – 9:30am: Registration, Refreshments, Opening Remarks
    - Innovation Hall, Room 103

- 9:30 – 10:30am: Keynote Address
    - Michelle Girvan "Modeling the dynamics of gene networks", Innovation Hall Room 103

- 10:30 – 10:40am: Break, Move to Breakout Rooms

- 10:40 – 12:00pm:
    - Parallel Session 1.1 (Innovation Hall, Room 133)
    - Parallel Session 1.2 (Innovation Hall, Room 134)

- 12:00 – 12:10pm: Break, Move back to main Conference room

- 12:10 – 1:50pm: Career Panel, Lunch
    - Innovation Hall, Room 103

- 1:50 – 2:00pm: Break, Social Networking

- 2:00 – 3:00pm: Keynote Address
    - Kathryn Brenan "Reflections of an applied mathematician: Formulas for success at the Aerospace Corporation", Innovation Hall Room 103

- 3:00 – 3:10pm: Break, Move to Breakout Rooms

- 3:10pm – 4:10pm:
    - Parallel Session 2.1 (Innovation Hall, Room 133)
    - Parallel Session 2.2 (Innovation Hall, Room 134)

- 4:10 – 4:30pm: Break, Move back to Main conference room

- 4:30 – 5:00pm: Awards Ceremony, Closing remarks

Schedule of talks

Session 1.1 (Room 133)

10:40 – 11:00am:
Kyle Shaw and Dan Weingarten (GMU) "Optimizing Surface Plasmon Generation"

11:00 – 11:20am:
Lorraine Feury (VA Tech) "Reliability of Electrical Power Grids"

11:20 – 11:40am:
Micholas Ducharme-Barth (W&M) "Harvesting Dynamics in Oyster Reef Sedimentation Model"

11:40 – 12:00pm:
Neeraj Vijay (GMU) "Effects of Momentum Trading on Asset Prices"

Session 1.2 (Room 134)

10:40 – 11:00am:
Owen Hill (W&M) "A relaxation of Steinberg's Conjecture"

11:00 – 11:20am:
Mauro Rubio and Brianna Lynn (GMU) "Static Two-Dimensional Deformation of Kitchen Sponges"

11:20 – 11:40am:
Benjamin Walsh (U.Maryland) "Cortical Representations of Speech and Music in Human Auditory Cortex"

11:40 – 12:00pm:
Catherine King (W&M) "Accurately Modeling Zooplankton Mortality Rates"

Session 2.1 (Room 133)

3:10 – 3:30pm:
Tyler Moran (W&M) "On Almost Normal Matrices"

3:30 – 3:50pm:
Lydia Krott (VA Tech) "Fourier Analysis of Ambisonic Recording"

3:50 – 4:10pm:
Rebecca Roberts (W&M) "Decomposition of unitary matrices and quantum gates"

Session 2.2 (Room 134)

3:10 – 3:30pm:
Ryan Gryder (W&M) "Global Dynamics of Pulse Coupled Oscillators"

3:30 – 3:50pm:
Daniel Luckett (W&M) "Bayesian Inference for the Generalized Inverted Exponential Distribution Based on Upper Record Values"

3:50 – 4:10pm:
Eric Cawi (GMU) "Paleoclimatology and Climate Field Reconstruction"