DEPARTMENT OF MATHEMATICS & STATISTICS
UNIVERSITY OF MAINE
Volume 2005, Issue 1 November 2005

FROM THE CHAIR'S DESK

Bill Bray

It hardly seems that a year has passed since the last newsletter. However, it indeed has been a year and an eventful one at that.

This fall, Assistant Professor André Khalil joined the Department. André received his PhD from the University of Laval in 2004 and spent the past year in a postdoctoral position at Jackson Lab in Bar Harbor. His PhD was in mathematics and astrophysics with specialty in image analysis of star clusters. Currently André's research has flowed over into the biomedical realm; his talents and training further the department's growth in interdisciplinary realms.

This Fall semester, the Department is piloting a new approach to mathematics learning – a computer learning center called the Math Den is now located on the first floor of Neville Hall. This year we are offering MAT 111, College Algebra through the Den. The concept is simple: course content, homework, quizzes and exams are all provided individually via computer software in the Den. The role of the instructor is now close to that of a coach; we also employ undergraduate and graduate students as tutors. This approach in low division service courses forces students to take a more active part in their learning process, and is an approach used with a high degree of success at other institutions. Jen Tyne is our lead instructor in the Den and we look forward to expanding the concept and the Den next year.

One challenge any Chair faces, particularly in times of limited resources, is rewarding faculty for their achievements. One possible reward is through reduced teaching for a semester to pursue research endeavors, grant writing, or education innovation. Of course, reduced teaching for some must be made up in other avenues. As this department makes headway towards the goal of becoming a research department, I have been working hard revamping our teaching schedule to accommodate faculty time for intellectual pursuits. As an outcome of this work, this Fall I started the Chair's Recognition for Outstanding Achievement. Just inside the main office door hangs the plaque of recognition. This year's faculty of recognition are: Professor Ramesh Gupta for his long term commitment to teaching and research in statistics, Assistant Professor Hiebeler for developing a research group including graduate and undergraduate students, and Lecturer Jen Tyne for her incredible work assisting in developing the aforementioned Math Den. All three received reduced teaching loads this year; if you see them around, give a pat on the back for their achievements.

In closing, we are well underway into another productive year remaining steadfast in our commitment to research and scholarship, excellence in teaching and service. □

2005 CHAIR'S RECOGNITION FOR OUTSTANDING ACHIEVEMENT RECIPIENTS

Dr. Ramesh Gupta

Dr. David Hiebeler

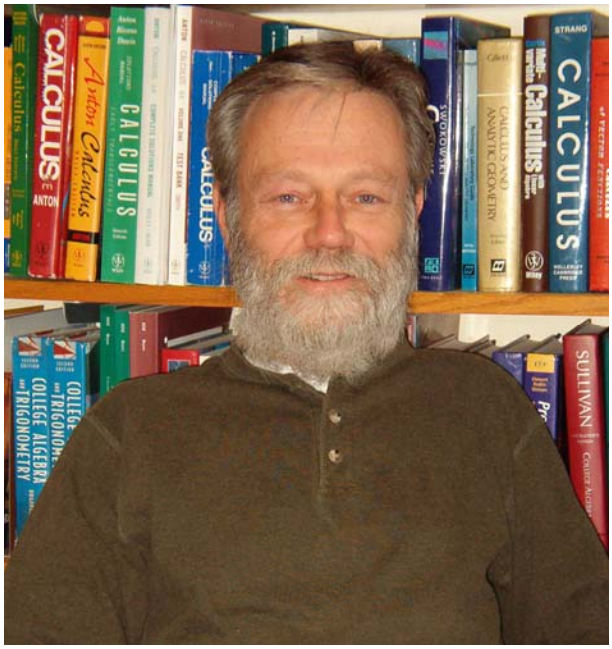
Mrs. Jenn Tyne

Sigma Phi Epsilon Fraternity Professor of the Year for 2005

M. Dube

Lecturer Paul Van Steenberghe was recognized on November 3, 2005 as the Sigma Phi Epsilon Fraternity Professor of the Year for 2005. Our winner has certainly touched the lives of many minds at the University of Maine. He has called UMaine home for many years, earning his undergraduate and graduate degrees at this campus, and has continued on to teach here for over two decades. He is a friend to many students on campus and a founding advisor to the nationally recognized solar vehicle team. In 2001, for his work with students on UMaine's solar vehicle team, he won the George Bradford Teacher Award from the Northeast Sustainable Energy Association. As a lecturer of mathematics he teaches much more than numbers. His interaction with students has taught essential life skills such as teamwork, interpersonal communication, and public relations. In the classroom students find his teaching style clear and relevant to their field. His tests are notoriously hard; however, he constantly works to ensure that we show improvement throughout the entire semester and beyond. Similarly, Sigma Phi Epsilon looks for our brothers to continuously improve themselves, to become balanced men.

Well Done Paul!



2005 Graduates

Congratulations to the undergraduate class of 2005:

Ana Andronache
Adam Barker-Hoyt (PHI)
David Bulkin (PSY)
Nicholas Cannon
Christa Combellick (EDS -MathEd)
Dustin Corey
Kyle Demilner
Scott Gray
Richard Knight, III (PHY)
George Matsoukatidis
Caroline Munsey
Thaddeus Rusinek
Zachary Smith (Minor in PHI)
Alexis Stevens (PHI)
Jason Tillotson (Minor in ENQ, WAT)

Education - Secondary Ed - Mathematics

Nicholas Gonzales
Zachary McIntyre
Mary Wood

Alumni

David Hiebeler has offered to maintain a webpage on the Department website of Alumni addresses, e-mail, and/or preferred ways to stay in touch with the University of Maine. Please send David your information if you would like to participate. hiebeler@math.umaine.edu □

The University of Maine Annual Fund allows you to restrict or designate gifts to support a specific University of Maine program, department, school, or college. Please consider a gift to the Department of Mathematics and Statistics. For more information please contact Bill Bray, Professor and Chair of the department, bray@math.umaine.edu or by phone 207.581.3900 or visit www.mainealumni.com/umaf/annualfund.htm.

INTRODUCING:

ANDRÉ KHALIL

Assistant Professor of Mathematics
Department of Mathematics & Statistics
University of Maine
Orono, ME
and
Adjunct Research Scientist
The Jackson Laboratory
Bar Harbor, ME

I grew up in a small town called Rimouski in the lower St. Lawrence River valley in Quebec, Canada and my little family and I moved to Maine in 2004. Growing up with Canadian winters in a small town setting certainly prepared us for the life here in Maine, which we like very much.

I am a member of the Institute for Molecular Biophysics (IMB), an interdisciplinary research program comprising researchers from Biology, Engineering, Mathematics, and Physics. My research is concentrated on the development and use of rigorously well-defined, quantitative, and objective image analysis tools. The goal is to keep up with technological advancements both in Astrophysics and Bio-Medicine. Indeed, the recent technological development of imaging and microscopy techniques has become quite important: The recent acquisition by the IMB of the 4Pi microscope (http://www.mpibpc.gwdg.de/abteilungen/200/4Pi.htm) at The Jackson Laboratory and the Canadian Galactic Plane Survey (http://www.ras.ucalgary.ca/CGPS/) are two good examples of great advancements in data acquisition. Therefore, to keep up with these breakthroughs, equally advanced, quantitative, and objective image analysis tools must be developed in order to characterize everything that this new technology has to offer. Everything from object segmentation to morphological and (multi)fractal analysis has to be defined and specifically adapted to get the most out of the data. The best way to accomplish this is in an interdisciplinary setting, where a good contact is kept between all members of this interdisciplinary team in order to guarantee an appropriate approach and a reliable interpretation of the results.

My work is centered on the development and application of two quantitative image analysis formalisms: The Metric Space Technique (MST) and the Wavelet-Transform Modulus Maxima Method (WTMMM). These two formalisms are based on several areas of Analysis and Topology, like metric spaces (actually, pseudo-metrics), connected sets, continuous but non-differentiable functions, power spectral (Fourier) analysis, wavelets, and fractal theory.

Several of our ongoing projects would greatly profit from the integration of undergraduate and graduate students with backgrounds in Biology, Computer Science, Engineering, Mathematics, and Physics. Please feel free to contact me for further information.

INTRODUCING:

ANDREW KNIGHTLY

Assistant Professor of Mathematics
Department of Mathematics & Statistics
University of Maine
Orono, ME

I joined the department in the Fall of 2004. My research is in number theory. Most of my work involves the interplay between analysis and arithmetic provided by the theory of modular forms. Modular forms are holomorphic functions on the complex upper half-plane which are (nearly) invariant under linear fractional transformations with integer coefficients. These functions have Fourier expansions whose coefficients contain a surprising amount of arithmetic information. For example, in some cases they encode the number of points on an elliptic curve over finite fields. This particular connection led to the solution of Fermat's last theorem by Wiles in 1994. Because of such interplay between modular forms and arithmetic, people want to know as much as they can about the Fourier coefficients.

This year I am finishing a book whose aim is to prove a trace formula from which one can recover the Fourier coefficients explicitly. This well-known formula has been around since 1974, but the purpose of the book is to recast the proof in more modern language, which has provided us with many new insights for related work. This is joint research with Charles Li at the Institute for Mathematics, Academia Sinica in Taiwan.

This also marks the second year of the University of Maine number theory seminar. We have weekly lectures on a given topic, and occasional talks by outside visitors. This year we are covering the details of Tate's 1950 thesis, which is a fundamental work forming the basis for the modern view of modular forms in the language of representation theory. The other regular participants are faculty members Ali Ozluk and Chip Snyder from our department, Peter Kleban from the Physics department, and UMaine Ph.D. alumnus Benjamin Elliot who is a faculty member at Unity College. □

MAINE-QUEBEC CONFERENCE ON NUMBER THEORY AND RELATED TOPICS

A. Knightly

The "Maine-Quebec Conference on Number Theory and Related Topics" is an annual two-day conference held on a weekend in early October. It was designed to bring together mathematicians from northern New England and the eastern provinces of Canada as well as invited participants from other areas. The conference was founded in 1998 by number theorists at ULaval and UMaine and changes venues each year between these two universities. This year's conference was held at UMaine on the weekend of Oct 1/2.

Among the nearly 30 participants were internationally respected mathematicians John Friedlander from the University of Toronto, John Labute from McGill University, and Solomon Friedberg of Boston College, each of whom gave 50 minute lectures on important new work. On the home front, Peter Kleban of the UMaine Physics Department presented a talk relating topics in physics and number theory.

Participants and speakers came from eastern Canada and the northeast US, including Harvard University, Massachusetts Institute of Technology, Dartmouth College, Rutgers University, and the universities of Ottawa and Laval, among others. Next year's conference will once again by hosted by number theorists at ULaval. □

THE RESULTS OF THE FIRST ANNUAL MATHEMATICS CONTEST

S. Lvin

In the Fall of 2004 the department of mathematics and statistics organized the first annual UM mathematics contest. Within five weeks students had to solve ten problems posted on the department website. Freshmen, sophomores and juniors, and seniors had different sets of problems. The awards were from $250 (first prize in each category) to $25 (an encouragement prize). Among the winners we have a business and financial major, engineering physics major, students with double major in mathematics and psychology, microbiology, electrical engineering and music. The next contest will in the fall of 2005.

FRESHMEN

First prize – not awarded

Second prizes ($100 each) –Jon Brophy
(engineering physics major)
Charles Boody (mathematics major)

Encouragement prize ($ 25) – Mahima Jaini
(marine biology major)

SOPHOMORES AND JUNIORS

First prize ($ 250) – Van Tran
(business and financial major)

Second prize ($ 100) - Amanda Criner
(mathematics and microbiology major)

Third prize ($ 50) – Adam Duncan
(mathematics and music major)

SENIORS

First prize ($ 250) – Dave Bulkin
(mathematics and psychology major)

Second prize ($ 100) - Vitaly Tkachuk
(mathematics and electrical engineering major)

MATHEMATICAL BIOLOGY RESEARCH GROUP

D. Hiebeler

As mentioned in the 2004 newsletter, my research mostly concerns various types of spatial models. I used to primarily think about applying the models to plants living in a heterogeneous landscape. I use stochastic spatial computer simulations and systems of ordinary differential equations to study these models. The mathematical models include various amounts of information about local spatial correlations, and approximations of higher-order terms.

Recently I've been using similar techniques to model the spread of a disease throughout a population, where the individuals are divided into groups which I call "households". These households may actually represent houses within a city, but they may also represent e.g. dorms within a school, schools within a neighborhood, neighborhoods within a city, cities within a region, and so on. The disease is more likely to spread among individuals within the same household, and then occasionally move between households. One can start out with an infinite-dimensional system of differential equations, and then truncate it to a small finite set of equations to study. The model shows that although the long-term fates of some diseases aren't affected by the movement patterns of individuals, the time-scale of the dynamics is. Controlling the movements of individuals may therefore provide extra time to develop other measures for controlling the disease.

Since the last newsletter came out, I have finished the prototype Java applets demonstrating spatial models I mentioned there. They are available at http://www.math.umaine.edu/faculty/hiebeler/java/CA/CellularAutomata.html

In Summer 2005, thanks to a UMaine Summer Faculty Research Fund award, I expanded on some of my earlier work regarding competing populations with mixed dispersal strategies on heterogeneous landscapes. I found ways to make some of my simulations much more efficient by avoiding wasted computations, and managed to add a bit of extra power to some old approximation techniques which most people (including myself) thought could not handle the type of spatial structure in these models.
In Fall 2005, I have four students working with me on various research projects: (Listed by their appearance in the photograph)
* Amanda Criner (undergrad): continuing to develop the household epidemiological model to study how variation in household size affects the dynamics
* Jennifer Houle (undergrad): looking at dynamics of populations on landscapes where the habitat distribution is dynamic but still spatially correlated; effects of spatial vs temporal variation in habitat
* Ben Morin (grad): looking at populations with spatially correlated disturbance events, on fixed landscapes with clustered heterogeneous habitat distributions
* David Gosselin (undergrad): studying different ways of implementing stochastic spatial simulations more efficiently, by filtering out events which won't affect the state of the system (such as failed colonization attempts) rather than explicitly simulating them as is usually done
We've been having regular group meetings which have been very stimulating!
During summer 2005, Ben and Amanda went to the 8-week Mathematical and Theoretical Biology Institute (MTBI) run by Carlos Castillo-Chavez of Arizona State University, held in Los Alamos, New Mexico. MTBI consists of four weeks of classes, followed by four weeks of the students working in groups on research projects. Jennifer spent the summer working on a research project with Prof. Susan McKay in the Dept of Physics and Astronomy here at UMaine. Below are their accounts of what they did:

Jen:
Over the summer I created a computer simulation of a two-dimensional Ising spin glass using the Metropolis algorithm. An Ising spin glass is a physical system which exhibits a slowing down at low temperatures due to its intrinsic properties, which makes it notoriously difficult to model. I used a version of the Metropolis algorithm with parallel tempering to obtain more accurate results. Parallel tempering involves running at least two simulations in parallel at different temperatures, and swapping data between them which has the effect of heating and cooling the low temperature system. Using parallel tempering, a low temperature spin glass system does not get stuck in one low energy basin in a rough energy landscape but instead explores all local minima to find the global minimum energy of the system. My results showed that parallel tempering lowered the autocorrelation time of the system, a measure of how self-similar data are over a period of time. Parallel tempering also made other calculations more accurate at lower temperatures.

Ben:
This summer as part of the MTBI I developed three models which can be used to analyze a model of similar species competition. The three models were a system of deterministic differential equations, an agent-based computer model and a multi-patch spatial model. Original analysis was done on the differential equations which resulted in conditions and stability for the nontrivial equilibrium (coexistence of both species) as well as limits on the number of coexistence equilibria present. While both the agent-based and multi-patch models provided additional insight into the behavior of the ants, they did not introduce any new behavior, aside from stochastic fluctuation from the dynamical system. The research received honors for best oral presentation at the Los Alamos Exposition 2005 in Mathematics. Look forward to my talk on more of the details sometime in December.

Amanda:
My group at MTBI examined two models. Our first model dealt with the infection of healthy cells by influenza virions. We included mutation and a variant-specific immune system in our model. I wrote a continuous-time Markov chain simulation for the model. I used the simulation to vary parameters to determine the effect of mutation on the total number of cells infected during the course of an infection. The simulation showed that increased mutation is an effective evasive strategy against the immune system. The second model incorporated phylogenetic distance into a population-level model of the spread of different variants of influenza through a population. We included a parameter to incorporate the difference between phylogenetic distance and antigenic distance. I wrote a simulation of this model as well to confirm that the parameter to weight for antigenic distance could affect the behavior of the system.

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Assistant Professor, Dept. of Mathematics and Statistics
University of Maine Orono, ME 04469-5752 USA □

From the University of Maine Website

Jen Tyne and Bob Franzosa (recipients of a 2005 Instructional Technology Grant) from Mathematics & Statistics are describing their project which incorporates streaming video to help students understand how to use other pieces of software.

Andrew Knightly (recipient of a 2005 Instructional Technology Grant) from the Mathematics & Statistics department is using online grading that provides students with instant feedback on their work.

University of Maine – Faculty Research Funds

Summer Faculty Research Competition FY 2005

The Summer Faculty Research competition provides $7,500 awards for faculty summer salaries for a minimum of 1.5 months research effort. Recipients are selected based on recommendations by the Faculty Research Funds Committee. Recipients from the Department of Mathematics and Statistics were:

David Hiebeler – Pair Approximations of Biological Invasion Models on Clustered Heterogeneous Landscapes

Andrew Knightly – Extra Twisting of Modular Forms

Tod Shockey – Creating Pedagogical Bridges through the Mathematical Underpinnings of Wabanaki Basketmaking

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