Duke University Math News

April 19, 2010

Graduating Class

Another school year, another class of excellent math majors.The 52 math majors and 27 math minors graduating this spring will scatter towards a variety of career paths including graduate school in mathematics, physics and computer science, medical school, high school teaching, and financial analysis and consulting. These students have each succeeded in one of the University's most challenging programs and this experience will prepare each of them for a rewarding career.

To those of you who are leaving Duke, we wish continued success. Do send Duke Math News a note from time to time. At the Graduation Luncheon following graduation exercises on May 16, first majors in math have the opportunity to introduce your family to your classmates and professors. Following the lunch, you will receive your diploma in a short and sweet ceremony.

Events

Exam Week Break

Math majors, graduate students and faculty are invited to a Study Break during the mid week reading period at 3pm on Wednesday May 5. This is the occasion for students and faculty to share food and conversation in an informal setting. It is also the time to honor the graduating students, contest participants and research students for their hard work and accomplishments. Many math majors will receive the 2010 Duke Math shirt and certificates and a few will be awarded generous cash prizes.

Conference on Fluid dynamics, Analysis, and Numerics

The Mathematics Department will host a conference from June 28 to 30 that will focus on aspects of mathematics related to fluid dynamics, ranging from rigorous analysis of nonlinear partial differential equations to the design and analysis of numerical methods and modeling of related physical systems. The conference recognizes the research contributions of Prof. J. Thomas Beale of Duke's Math Department. It will feature talks by 18 researchers and an extended poster session for research presentations by conference participants. The conference is sponsored by Duke University, Drexel University, North Carolina State University, and the National Science Foundation.
`http://www.math.duke.edu/conferences/FAN2010`

Undergraduate News

Organizations for Math Students

The Duke University Math Union organizes activities ranging from dinners, socials and games nights to major events described below. Contact DUMU secretary Yingyi Shen (yingyi.shen@gmail.com) to get on the mailing list.

Duke graduate students have organized a Noetherian Ring, an organization that sponsors activities and provides encouragement for women in mathematics. Undergraduates are encouraged to attend the events. More details follow in the Graduate Student News section below.

This organization is modeled after those established at the University of California, Berkeley, and Princeton University. To get on the mailing list for events, send a note to Sarah Schott (schott@math.duke.edu).

Alumni Lecture

The Duke University Math Union and math department hosted a lecture by Duke alumnus Craig Gentry '95 last February. Gentry, currently a research scientist at IBM, achieved a breakthrough recently in the theory of encryption. He described a method to securely encrypt data so any mathematical calculation can be applied to it while maintaining its encryption. (Some call it a "blindfolded calculator".) This may be a very important development in the future of cloud computing, as it opens the door for sensitive data to be manipulated on servers with imperfect security.

The problem Gentry solved was first posed 30 years ago by some of the founders of modern cryptography, including Rivest and Adelman, two architects of the "RSA" scheme that dominates online encryption today. They concluded it was probably impossible!

Gentry has an unconventional background: he was a math major and Putnam Fellow at Duke, went to Harvard Law School and became an intellectual property lawyer. Just a few years ago he returned to school and got a PhD at Stanford.

Duke Math Meet

The Duke math meet attracted a record 49 teams and nearly 300 high school students on Saturday October 31. Teams came from as far as New Jersey and Alabama to compete in this annual ARML style meet.

Teams from A.A.S.T, a magnet public high school in Bergen County, NJ, took first and fifth places. Teams from the Thomas Jefferson HSST in VA placed second and third with fourth place going to a team from Durham's NCSSM.

Allen Yang of Cary Academy finished first in the individual standings with Ben Gunby of Georgetown Academy, Bryce Taylor of NCSSM, Xinke Guo-Xue from Vestavia Hills, AL, and Calvin Deng of Enloe in Raleigh following closely behind.

For this event, DUMU members invite the teams, create the math problems, distribute the lunches, grade the students' papers and present awards to the winning teams and individuals. In the morning, teams were sent to scores of classrooms on West Campus to solve the challenging Power Problem. After a leisurely lunch on the French Science Terrace, they returned for another series of contest problems, including the fast paced Relay and Devil rounds.

Special thanks are due to Math Meet coordinator, Vivek Bhattacharya for his outstanding leadership and trouble shooting and to Siyang Chen for the design of the tournament Halloween style math shirt

Putnam Competition

The Duke team of Misha Lavrov, Matt Rognlie and Peng Shi finished sixth in the 70th William Lowell Putnam Competition. Lavrov received Honorable Mention and Rognlie, Shi, and Top Chongchitmate ranked among the top 100 of the 4036 participants from 546 colleges and universities in the US and Canada. Thames SaeSue, Calvin Hayes and Daniel Vitek finished among the top 5% while Alan Guo, Siyang Chen and Joseph Keefer ranked among the top 12%.

A team from MIT finished first followed by Harvard, Cal Tech, Stanford and Princeton. This is the fifteenth straight year that a team from Duke has finished among the top ten. `http://www.math.duke.edu/news/awards/competitions.html#putnam`

Mathematics Contest in Modeling

More than 2200 teams of three undergraduates from around the world competed in the 2010 Mathematics Contest in Modeling. The team of Sophomores Veronica Ciocanel and Yingyi Shen and Jiaqi Yan was named Finalist (top 1%) and awarded the Ben Fusaro award for originality. The team of Alan Guo '11, Vivek Bhattacharya '12 and Daniel Vitek '13 was also named Finalist. These teams developed an algorithm to aid police in their investigation and apprehension of serial criminals.

A Meritorious Award went to HyungJu (Danniel) Jeon, So Youn Lee and Jungmo Ryu. Honorable Mention was given to Ethan Yong-Hui Goh, Donny Lee and Peichun Wang. Each of these teams proposed methods to locate the "sweet spot" on baseball bats. `http://www.math.duke.edu/news/awards/competitions.html#modeling`

Menger Prize

The 2010 Menger Prize awarded for excellence in math competitions was awarded to Wu-

tichai Chongchitmate, Misha Lavrov, Matt Rognlie and Peng Shi for their success in the Putnam math competition and to MCM Finalists Veronica Ciocanel, Yingyi Shen, Jiaqi Yan, Vivek Bhattacharya, Alan Guo and Daniel Vitek.
`http://www.duke.edu/news/awards/menger/`

Julia Dale Prize

The Julia Dale prize for excellence in mathematics will be shared this year by seniors Wutichai (Top) Chongchitmate, Jason D. Lee and Matthew Rognlie. Each of these students has excelled in seven graduate math courses at Duke and all have completed major research projects.

Top Chongchitmate has completed two major research projects, the first in group theory with advisor Chad Schoen and the second in knot theory with advisor Lenny Ng. Top will pursue a doctorate in mathematics at UCLA after which he plans to return to Thailand to teach mathematics at a university.

Jason Lee has also completed several major research projects at Duke and elsewhere. His senior thesis was written under the direction of Mauro Maggioni. Jason has been awarded a national defense fellowship (NDSEG) to attend the Institute of Computational Mathematics and Engineering at Stanford where he will study the mathematics of data.

Although his first major is mathematics and his second is computer science, Matt Rognlie has written his senior thesis in the field of financial econometrics. He is an AB Duke Scholar and a Faculty Scholar and served as president of DUMU. Matt will attend the graduate program in Economics at MIT.

The winners of the Freshmen Julia Dale prize are Michael Banaszek, Jim Mallernee, and TongTong Zhan. Each will receive a cash award for their outstanding academics.
`http://www.duke.edu/news/awards/dale/`

Undergraduate Research

Four PRUV Fellows will graduate with distinction in mathematics this year in recognition of their senior thesis on a challenging mathematical problem under the direction of a Duke professor.

Wutichai Chongchitmate *Classification of Legendrean knots*, mentor Lenny Ng He plans to study topology at UCLA next year.

Jason Lee *Multiscale analysis of dynamic graphs* , mentor Mauro Maggioni. He plans to study data analysis at Stanford University next year.

Jeremy Semko *Droplets coating a hydrophobic surface*, mentor Tom Witelski. He plans to study Algebra or Number Theory at UCSD next year.

Amy Wen *Dynamics of coupled nephrons*, mentor Anita Layton. She plans to attend medical school.

The following sophomores and juniors have recently been named PRUV Fellows Each will receive a stipend for the summer to concentrate on a research problem in mathematics and their applications.

Veronica Ciocanel, Kaitlin Daniels, Theo Frelinghuysen, Anna Kuznetsova, Misha Lavrov, Philip Pham, Yingyi Shen, Bo Waggoner, Peichun Wang `http://math.duke.edu/vigre/pruv/`.

See `http://www.math.duke.edu/news/awards/research.html#senior` for a list of previous students who graduated with distinction in mathematics.

Freshmen Seminars in Fall 2010

Math 49S-01, Lenny Ng: *The Magic of Numbers*

This course will explore some of the intriguing and beautiful mathematics that underlies the arts, technology, and everyday life. If you are interested in learning about how to discover and analyze patterns using mathematics, but don't necessarily have a strong technical background in math, this may be the seminar for you.

We will explore a selection of elegant and accessible subjects that will expose us to a broad variety of mathematical disciplines, from combinatorics (the mathematics of counting) to geometry (the mathematics of shapes) to number theory (the mathematics of whole numbers). We'll see how the golden ratio and a number sequence called the Fibonacci numbers appear throughout nature, music, and other "non-mathematical" areas; how games of chance can be understood through some simple counting arguments; how the ancient Greeks found order and symmetry in three-dimensional shapes;

and how factoring whole numbers leads to "unbreakable" codes like the ones that underlie internet security. Emphasis will be placed on understanding and crafting rigorous mathematical arguments, and appreciating ways in which mathematical patterns can be applied to society and the natural world. The seminar will be interactive and will feature hands-on demonstrations and multimedia where appropriate.

Math 49S-02, Hugh Bray: *Game Theory & Democracy*

As the trend towards democracy continues, the question of determining what democracy actually means becomes increasingly important. For example, given a finite number of choices, how does a group of equals choose the option which "best" reflects the will of the group? With two choices, the accepted answer is "majority rule." However, in the case of decisions with more than two options, this is an open question in the sense that philosophical notions of "best" are not universally agreed upon. In this seminar, we will use mathematics to aid us in our discussion on the meaning of democracy and to examine the pros and cons of different approaches to this question. We will discuss preferential ballot elections (where each voter ranks all of the choices) and cover some of the most common vote counting methods used to determine a winner in a preferential ballot election. We will see how some of the most "obvious" vote counting methods, such as Instant Runoff Voting (used on many college campuses), have some significant theoretical defects. Finally, the seminar will include an introduction to game theory which is an essential tool for predicting how intelligent people with agendas behave given carefully defined rules.

Graduate Student News

Graduating Ph.D. Students 2009-2010

Jeffrey Jauregui, Ph.D.
Mass Estimates, Conformal Techniques, and Singularities in General Relativity
Advisor: Hubert Bray
He has accepted a Postdoc position at University of Pennsylvania.

Rachel Thomas, Ph.D.
Time-Scaled Stochastic Input to Biochemical Reaction Networks
Advisors: Michael Reed and Jonathan Mattingly
She will be a quantitative analyst for Excelon Corporation in Kennett Square, PA.

Noetherian Ring

Inspired by a similar program at Princeton University, the Duke Mathematics department is now host to a Noetherian Ring. Named in honor of the mathematician Emmy Noether, the Noetherian Ring is an organization of female mathematicians at Duke, consisting of undergraduates, graduate students, post-doctorates and faculty. Activities range from the academic (including invited female speakers and a monthly brown bag lunch seminar) to the social (such as dinner with speakers). The goal of this organization is both networking among mathematicians, as well as enhanced support and encouragement for women in math.
- Sarah Schott

Special Graduate Courses in Fall 2010

Math 264, Yuri Mileyko: *Computational Topology*

The course is an introduction to computational topology, which is an emerging field devoted to the study of efficient algorithms for topological problems, especially those arising in science and engineering. Computational topology builds upon classical results from algebraic, geometric, and differential topology as well as algorithmic tools from computational geometry and other areas of computer science. Specific topics will include elements of point-set topology (topological and metric spaces, continuity, homeomorphism), manifolds (curves, knots, surfaces and beyond), fundamental group, homotopy, simplicial complexes (Alpha, Cech, Rips), simplicial homology and cohomology, duality, Morse theory, persistent homology, stability of persistence diagrams, and applications of computational topology with a focus on data analysis.

Exposition of most topics will have both theoretical and algorithmic parts.

Math 288, Rick Durrett: *Topics in Probability: Random Graphs*

The course will be an introduction to random graphs which will begin by following my book Random Graph Dynamics. We'll begin with the classic story of the Erdos-Renyi random graph and the phase transition which results in a giant component. We will then consider other degree distributions (especially those with a power law tail) and other algorithms for generating graphs: the small world model, preferential attachment, and the CHKNS procedure which grows a random graph with a very interesting (Kosterlitz-Thouless) phase transition. Once we have mastered the geometry of random graphs we will turn to the study of dynamics taking place on them: epidemics, random walks, the voter model, etc. Much of this material is more recent than my book, see e.g., my article "Some features of the spread of epidemics and information on a random graph." PNAS 107 (2010), 4491-4498. Our emphasis will be on proving theorems, but we will emphasize ideas behind the proofs rather than slugging through all the details so it should tolerable for those who want to know what is true rather than why. This course should be a good introduction to the activities at the SAMSI year on complex networks which will have its own tutorial course.

Math 389, Manoj Gopalkrishnan: *Foundations of Nanoscience*

The study of nature at the nanoscale is an ongoing research endeavor that has benefited from inputs from various disciplines including molecular biology, statistical physics and computer science. We will focus on the problem of designing nanosystems to exhibit a desired complex behavior. Topics will be chosen from DNA computing and self-assembly, tile assembly models, DNA circuits, chemical kinetics, catalysis, Maxwell's demon, flashing ratchet models, physics of computation, in vitro evolution. It will be assumed that participants are familiar with, or willing to learn, the basics of chemistry, physics, computer science, linear algebra, probability theory and differential equations. This course may be appropriate for graduate students from math, computer science, engineering, and the physical sciences.

Duke Math News

The *Duke Math News* is published several times a year and is distributed to those in the Duke mathematics community. For previous editions and other news, see `http://www.math.duke.edu/news/`. We welcome items of interest for our next issue. Send them to `dept@math.duke.edu` or `dkrain@duke.edu`

To read about other news, honors and events concerning mathematics at Duke, visit `http://www.math.duke.edu/news/`. The on-line calendar at `http://www.math.duke.edu/mcal` lists both regular and special seminars and colloquia for the upcoming weeks. The department maintains video archives of talks, lecture series and special conferences at Duke, many of which are available, online. See `http://www.math.duke.edu/computing/broadcast.html` for more information.

—*David Kraines, DMN Faculty Sponsor*

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