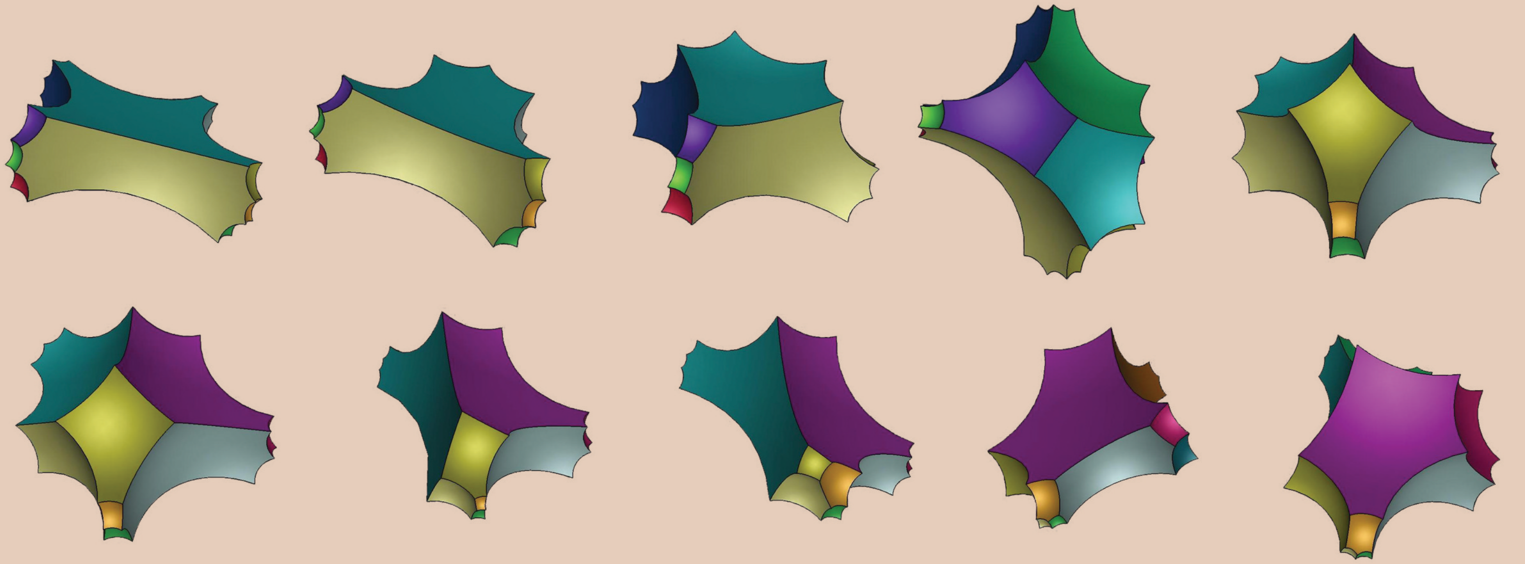
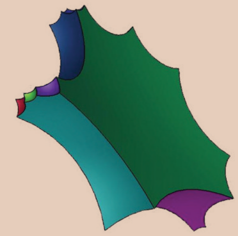
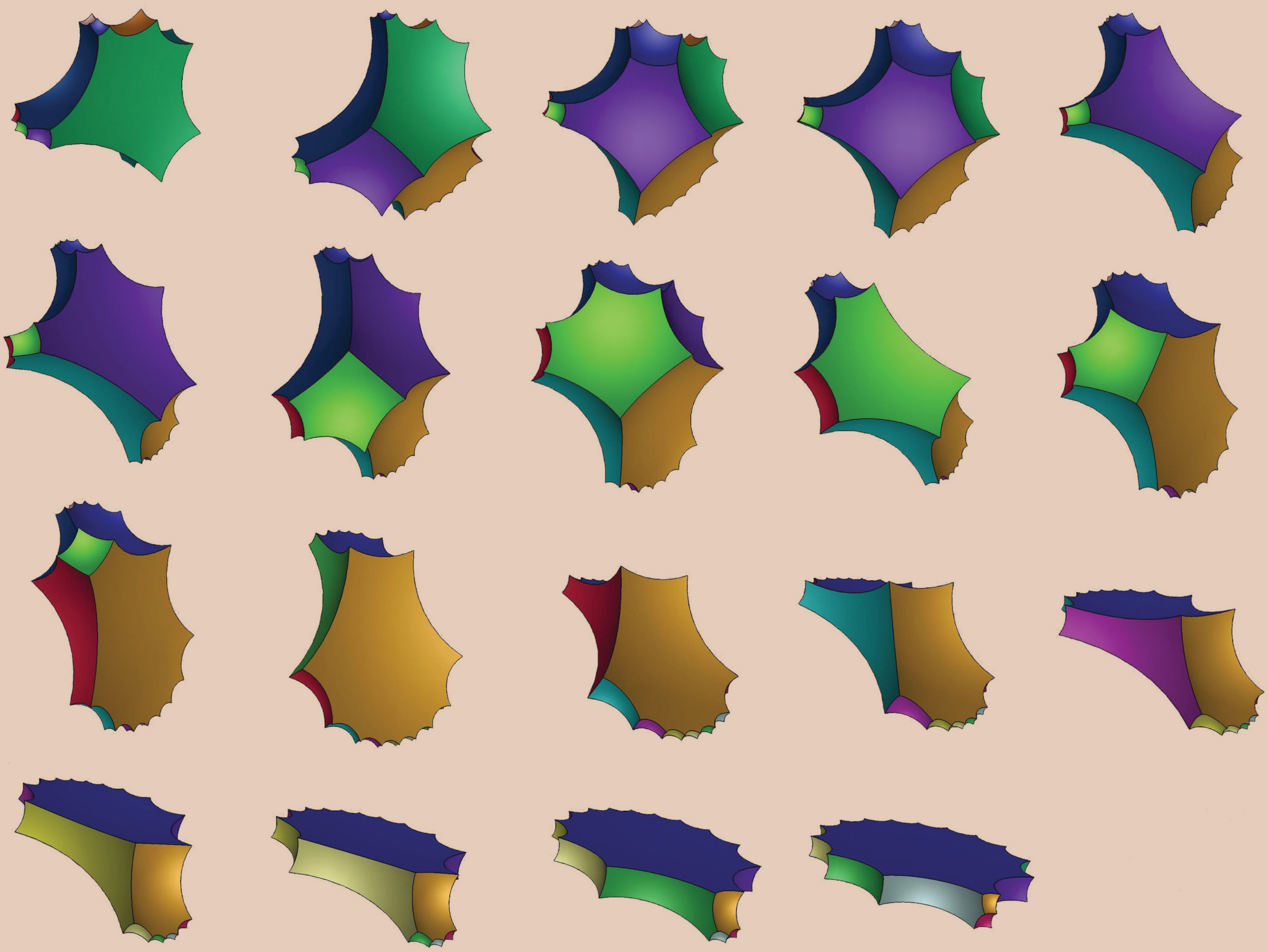


CORNELL

DEPARTMENT OF MATHEMATICS

Annual Report 2003–2004





Cover art by Roland Roeder (pictured left): In 1970, E. M. Andreev proved a complete classification of 3-dimensional compact hyperbolic polyhedra having dihedral angles (the angle between a pair of faces) that are non-obtuse. A key part of Andreev's proof shows how to construct a hyperbolic polyhedron with some given desired combinatorics by doing a sequence of combinatorial modifications to a "simple" polyhedron. In December of 2002, Roland Roeder, a graduate student in the Cornell University Department of Mathematics, found an error in this part of Andreev's proof and found a correction of Andreev's proof in March of 2003. The cover shows a sequence of 34 polyhedra (four of them obscured by text) calculated using Roeder's correction of Andreev's proof, showing the combinatorial changes from the polyhedron in the upper left to the "simple" polyhedron in the lower right. The sequence is repeated on the back cover.

CORNELL UNIVERSITY
DEPARTMENT OF MATHEMATICS

ANNUAL REPORT 2003-2004

The Department of Mathematics at Cornell University is known throughout the world for its distinguished faculty and stimulating mathematical atmosphere. There are close to 40 tenured and tenure-track faculty — representing a broad spectrum of current mathematical research — a lively group of postdoctoral fellows and frequent research and teaching visitors. The graduate program includes over 70 graduate students from many different countries. The undergraduate program includes several math major programs, and the department offers a wide selection of courses for all types of users of mathematics.

The Cornell Mathematics Department is part of the College of Arts and Sciences, one of the endowed (or private) units of Cornell, which includes 40 departments in the humanities, social sciences, and the physical and natural sciences. There are approximately 19,000 students at Cornell, of which 14,000 are undergraduates.

Cornell University is situated on a hill between two spectacular gorges that run down to Cayuga Lake in the beautiful Finger Lakes region of New York state. After 110 years in White Hall, the department moved to newly renovated Malott Hall, in the center of the Cornell campus. Renovation of Malott Hall was completed in 1999 to the specifications of the department. Its amenities include a spacious Mathematics Library, which houses one of the most extensive mathematics collections in the country, seminar rooms, classrooms and lecture rooms of all sizes, state-of-the-art computer facilities, and a large lounge with comfortable furniture and wall-to-wall blackboards.

Department Chair:	Prof. Kenneth Brown
Director of Undergraduate Studies (DUS):	Prof. Birgit Speh
Director of Graduate Studies (DGS):	Prof. Michael Stillman
Director of Teaching Assistant Programs:	Dr. Maria Terrell
Administrative Manager:	Colette Walls

Department of Mathematics, 310 Malott Hall, Cornell University, Ithaca, NY 14853-4201
Phone: (607) 255-4013 Fax: (607) 255-7149 email: *math@math.cornell.edu*

September 21, 2004

Dear friends and colleagues,

The major event of the past year was an external review, our first in about 30 years. Preparing for this was a major effort, but it was worth it. The review team was outstanding and made many good suggestions, mostly concerning hiring. The reviewers were Alice Chang (Princeton University), Phil Hanlon (University of Michigan), Ron Stern (University of California at Irvine), and Dan Stroock (Massachusetts Institute of Technology). They spent an intense 2 1/2 days on campus in February, after which I and many other faculty members felt energized and ready to do some serious planning for the future.

As a direct result of the review we held a faculty retreat in April, at the Benn Conger Inn in Groton. Our Faculty Search Committee, under the leadership of Laurent Saloff-Coste, decided on the organizational structure. None of us had any idea what to expect, but I think the retreat was pretty successful for a first effort. I hope to make it an annual event.

The goal of this year's retreat was to make a comprehensive hiring plan for the next 5-10 years. We were, in fact, able to reach a consensus on our needs and prepare a hiring plan, which we sent to the dean's office. Negotiations with the dean will begin in the fall to discuss implementation of the plan.

Another major event of the year, this one tragic, was the death of José (Chepe) Escobar, in the prime of his career at age 49. (See page 4.) We were all deeply saddened by the news. The loss of Chepe leaves a big hole in our department, which will be very hard to fill. In terms of the department's needs, he was our only differential geometer, and we have to start from scratch to rebuild this area. In addition, he was our only Latino faculty member, and he played a major role in the recruitment of minority graduate students. On a personal level, he will be missed by all who knew him. Our deepest sympathy goes out to his family and friends.

Returning to good news, we had an extremely successful postdoc hiring season. We have five new postdocs coming, including four H. C. Wang assistant professors and one NSF postdoc. (See page 4.) We only had one offer rejected, so the five who are coming are five of our top six candidates.

We are also pleased to have hired a new tenure-track assistant professor, Alex Vladimirsky, and a new senior lecturer, Dave Bock. (See page 4.) And we welcome Irena Peeva to the tenured faculty. Irena, an internationally known algebraist, was promoted to associate professor with indefinite tenure effective November 1, 2003.

As I begin my third year as department chair, I continue to be grateful for the opportunity to serve this fine department. I would not be able to do the job without the help and support of an excellent staff, under the direction of administrative manager Colette Walls. And I am grateful to my colleagues on the faculty for their enormous effort on behalf of the department. I'd like to single out a few who have played major roles.

Birgit Speh has completed her three-year term as director of undergraduate studies. She was an active and energetic DUS who worked tirelessly on our undergraduate program. She is responsible for several important changes. Allen Hatcher has succeeded Birgit as of July 1, 2004.

Mike Stillman has completed his second year as director of graduate studies. Mike cares deeply about the welfare of our graduate students, and I am very happy that he has agreed to serve one more year.

Maria Terrell, senior lecturer and director of teaching assistant programs, is a constant source of new ideas. Some of her experimental teaching innovations are described on page 19, and we eagerly await further developments.

Finally, Rick Durrett continues to do an outstanding job as VIGRE director (see pages 7–8). He single-handedly revitalized the Math Explorer's Club (page 42), and he is currently putting in a huge amount of time and effort on our new VIGRE proposal, which is due in October.

Sincerely yours,

Ken Brown

Awards and Honors

In June 2003 a conference was organized at the University of Cagliari in Sardinia in honor of **Lawrence Payne** on the occasion of his 80th birthday. A special issue of ZAMP was dedicated to him in September.

Professor John Guckenheimer was appointed to a panel of international mathematicians of the highest standing to conduct an International Review of Mathematics in the United Kingdom. The review, which took place in early December 2003, was the sixth in a series organized jointly by The Engineering & Physical Sciences Research Council (EPSRC) and the Council for the Mathematical Sciences (CMS) to review the standing, quality and potential of mathematics research in the UK. The review aimed to establish an independent assessment of the quality of UK research compared with international standards. Prof. Guckenheimer was also elected chair of SIAM's Dynamical Systems Activity Group.

On April 30, 2004, the American Academy of Arts & Sciences announced the election of 178 new Fellows, including our own **Prof. Leonard Gross**. The Academy will welcome this year's new Fellows and Foreign Honorary Members at its annual Induction Ceremony in October at the Academy's headquarters in Cambridge, Massachusetts. Election to the Academy has always been one of the highest honors in the United States. The Academy has welcomed the finest minds and most influential leaders from each generation, including George Washington and Ben Franklin in the 18th century, Daniel Webster and Ralph Waldo Emerson in the 19th, and Albert Einstein and Winston Churchill in the 20th. Current membership of over 4,500 includes more than 150 Nobel laureates and 50 Pulitzer Prize winners. Richard Durrett (2002), Harry Kesten (1999), and Eugene Dynkin (1978) are also members.

Professor Louis Billera has been invited to be a 2004-2005 Distinguished Ordway Visitor at the University of Minnesota's School of Mathematics. The Distinguished Ordway Visitors Program brings highly distinguished mathematicians to Minneapolis for prolonged periods, significantly enhancing the creative environment of the School. The visitors typically give several lectures, including a colloquium lecture and several seminars, and the exchanges of ideas with Minnesota faculty and students often result in research collaborations.

The Association of Computer Science Undergraduates (ACSU) has selected **Graeme Bailey** as Faculty of the Year. With over 200 members spanning the Engineering and Arts colleges, ACSU is the largest academic student organization on campus. Each year, their members determine the Faculty of the Year by popular vote. All CS faculty are eligible, but the results usually lean towards those who teach the core curriculum. Being a cheerful and multi-talented guy, Graeme is always popular. He excels in a broad number of topics ranging from databases and web technologies to cryptography, and he is equally talented in music composition and motorcycle riding. Graeme's courses, challenging yet fair, earned him the reputation for this award.

One graduate student and four undergraduate majors were recognized with Cornell awards this year. **Christopher Francisco,** a fifth-year graduate student, is the recipient of a *Clark Distinguished Teaching Award*. (See Teaching Program, p. 16.) Graduating seniors **Michelle Fullwood, Brian Lukoff,** and **Tian Tian Grace Qiu** were named *Cornell Merrill Presidential Scholars*. Grace named **John Hubbard** as the faculty member who influenced her the most. In addition, senior mathematics major **Mushfeq Khan** was awarded second place in the *Knight Competition for Writing in the Majors*. (See Undergraduate Program, p. 28.)

Department Prizes and Awards

Department Teaching Awards

Senior Faculty Award:	Maria Terrell
Junior Faculty Award:	Dan Zaffran
Graduate Student Award:	Dan Ciubotaru

Graduate Student Awards

Battig Graduate Prize:	James Belk
	Harrison Zhou
Hutchinson Fellowships:	Jason Martin
	Melanie Pivarski
York Award:	Farkhod Eshmatov
	Matija Cuk (Astronomy)

Harry S. Kieval Prize in Mathematics

Tian Tian Grace Qiu
Asher Walkover

Freshman Math Prize Exam

First prize:	Zachary Scherr
Second prize (tied):	Thiti Taychatanapat, Evan Marshak
Third prize (tied):	Ameya Agaskar, Joshua Wiener

Michael D. Morley Ithaca High School Prize in Mathematics

Thomas Brennan

Mathematics Department Directory 2003-2004

Professors
Dan Barbasch
Louis Billera
Kenneth Brown, chair
Stephen Chase
Robert Connelly
R. Keith Dennis
Richard Durrett
Eugene Dynkin
Clifford Earle
José Escobar
Leonard Gross
John Guckenheimer
Allen Hatcher
David Henderson
John Hubbard
J. T. Gene Hwang
Yulij Ilyashenko
Peter Kahn
Gregory Lawler
Anil Nerode
Michael Nussbaum
Laurent Saloff-Coste
Alfred Schatz
Shankar Sen
Richard Shore
John Smillie
Birgit Speh
Michael Stillman
Robert Strichartz
William Thurston
Karen Vogtmann
Lars Wahlbin
James West

Professors Emeritus
James Bramble
Marshall Cohen
Roger Farrell
Harry Kesten
G. Roger Livesay
Michael Morley
Lawrence Payne
Alex Rosenberg
Moss Sweedler

Associate Professors
Irena Peeva
Ravi Ramakrishna
Reyer Sjamaar

Assistant Professors
Yuri Berest
Camil Muscalu
Edward Swartz

H.C. Wang Assistant Professors
Nathan Broaddus
Kai-Uwe Bux
Indira Chatterji
Barbara Csima
Martin Dindos
Irina Mitrea
Kasso Okoudjou
Rodrigo Perez
Jason Schweinsberg
Alexander Vladimirsky
Kevin Wortman
Dan Zaffran

2003-2004 Faculty Leaves

Indira Chatterji	leave, fall 2003
Sarah Day	leave, academic year
R. Keith Dennis	administrative leave, fall 2003
Eugene Dynkin	sabbatical leave, fall 2003
José F. Escobar	sabbatical leave, fall 2003
Allen Hatcher	sabbatical leave, academic year
John Hubbard	sabbatical leave, academic year
Camil Muscalu	leave, academic year
Anil Nerode	administrative leave, fall 2003
Ravi Ramakrishna	leave, fall 2003
John Smillie	administrative leave, fall 2003
William Thurston	leave, fall 2003

VIGRE Assistant Professors
Tara Brendle
Hsiao-Bing Cheng
Sarah Day
Matthew Fickus
Paul Jung
Alexander Meadows
Brian Smith
Lawren Smithline

Senior Lecturers
Allen Back
Avery Solomon
Maria Terrell
Robert Terrell

Lecturer
Patricia Alessi

Senior Research Associate
Daina Taimina (fall)

Adjunct Professor
Graeme Bailey

Field Members

Timothy Healey	(T&AM)
Dexter Kozen	(Computer Science)
Philip Protter	(OR&IE)
Richard Rand	(T&AM)
James Renegar	(OR&IE)
Steven Strogatz	(T&AM)

Visiting Faculty
Stephen Andrea
Alexander Bendikov
Oleg Chalykh
Vesselin Gasharov
Takashi Kumagai (fall)
Gerhard Michler
Piergiorgio Odifreddi
Victor Protsak
Rajmohan Rajagopalan
Lawren Smithline
Daina Taimina (spring)

Visiting Program Participants
Mercedes Franco
Stephen Hilbert
Mark McClure
John Thurber

Visiting Scholars
Karen Ames
Takashi Kumagai (spring)
Louise Raphael

Teaching Associates
Richard Furnas

Graduate Students
Bryant Adams
Drew Armstrong
James Belk
David Benbennick
Nathanael Berestycki
Janet Best
David Biddle
Jason Bode
Joshua Bowman
Kristin Camenga
Andrew Cameron
Edoardo Carta
Benjamin Chan
Nelia Charalambous
Guan-Yu Chen (nondegree)
Liang Chen
Dan Ciubotaru
Jean Cortissoz
Nikolai Dimitrov
Alimjon Eshmatov
Farkhod Eshmatov
Jennifer Fawcett
Bradley Forrest
Christopher Francisco
Yuval Gabay
Lee Gibson
Timothy Goldberg
Noam Greenberg
William Gryc
Pavel Gyrya
Radu Haiduc
Spencer Hamblen
Christopher Hardin
Heather Heston
Henri Johnston
Todd Kemp
Evgueni Klebanov
Sarah Koch
Michael Kozdron (nondegree)
JaEun Ku
Dmitriy Leykekhman
Hway Kiong Lim
Yi Lin
Chris Alan Lipa
Fernando Marques
Jason Martin
Francesco Matucci (nondegree)
Andrei Maxim
Jeffrey Mermin
Mia Minnes
Vadims Moldavskis
Antonio Montalban
Steven Morris
Radu Murgescu
Jonathan Needleman
Matthew Noonan
Michael O'Connor
Melanie Pivarski
Roland Roeder
Franco Saliola
Everilis Santana-Vega
Marie Sawicki (nondegree)
Hasanjan Sayit
Fernando Schwartz
Jay Schweig
Achilleas Sinefakopoulos
Steven Sinnott
Sergey Slavnov
Maria Sloughter
Aaron Solo
John Thacker
José Antonio Trujillo Ferreras
Mauricio Velasco
Anael Verdugo
Brigitta Vermesi
Shawn Walker
Treven Wall
Biao Wang
Russell Woodroofe
James Worthington
Yan Zeng
Yan Zhang
Harrison Huibin Zhou
Jessica Zuniga

Administrative Support Staff
Linda Clasby
Arletta Havlik
Joy Jones
Michelle Klinger
Gayle Lippincott
Donna Smith
Catherine Stevens
Colette Walls, manager

Computer Consultants
Douglas Alfors
Allen Back (through 6/1/04)
Steven Gaarder (effective 5/19/04)

Instructional Computer Lab
Todd Cullen, director

Mathematics Support Center
Douglas Alfors, director
Richard Furnas

Mathematics Library Staff
Steven Rockey, librarian
Natalie Sheridan

Graduate students held a gingerbread house contest this year in celebration of the holiday season. Here is the winner, constructed by a team of second-year graduate students.

Faculty, Staff and Graduate Student Changes for 2004-2005

A Memorial to José Escobar

It is with great sadness that we report Prof. José F. Escobar passed away on January 3, 2004 while on sabbatical leave in Colombia. Prof. Escobar joined the faculty at Cornell on July 1, 1994, after teaching at Indiana University, the University of Chicago, and the Courant Institute at New York University. During his career, he received numerous academic awards and honors, most notably an Alfred P. Sloan Dissertation Fellowship (1985–86) and a Presidential Faculty Fellowship in pure mathematics (1992–97). He was a vital part of our community, and he will be sorely missed.

Faculty Who Have Left Cornell

(Includes destination, if known)

Kai-Uwe Bux	Univ. of Virginia, Charlottesville
Martin Dindos	Brown University
Matthew Fickus	Air Force Institute of Technology
Irina Mitrea	Univ. of Virginia, Charlottesville
Jason Schweinsberg	Univ. of California, San Diego

Ph.D. Recipients

(Includes location of first position; details on pp. 24–26)

Janet Best	Ohio State University
Matthew Horak	Trinity College
Samuel Hsiao	University of Michigan
Fernando Marques	Instituto Nacional de Matemática Pura e Aplicada (Brazil)
Rebecca Schuller	ALPHATECH, Inc.
Shawn Walker	undecided

New Faculty and Graduate Students

(Includes Ph.D. institution for faculty and undergraduate institution for graduate students.)

Assistant Professor

Alexander Vladimirsky	University of California, Berkeley

Senior Lecturer

David Bock	SUNY at Albany (M.S.)

H. C. Wang Assistant Professors

Kariane Calta	University of Chicago
Martin Kassabov	Yale University
Alessandra Pantano	Princeton University
Etienne Rassart	MIT
Luke Rogers	Yale University

Graduate Students

Owen Baker	North Carolina State University
Raymond Cassella	SUNY, Stony Brook
Guan-Yu Chen	National Chiao Tung University
Laure Fumex*	University of Paris 7
Christophe Garban*	University of Paris
Noam Horwitz*	Tel Aviv University
Robyn Miller*	Mount Holyoke College
Gregory Muller	Rutgers University
Philip Mummert	Purdue University
Artem Pulemotov	Kyiv T. Shevchenko University
Ingvar Sigurjonsson	University of Iceland
Gwyneth Whieldon	St. Mary's College of Maryland
John Workman	University of Tennessee
Zhigen Zhao	Nankai University

**Fumex, Garban, and Mummert are nondegree students.*

2004-2005 Visiting Faculty

(Includes the faculty members' home institutions.)

Vesselin Gasharov	N/A
Andrzej Hulanicki	Wroclaw University (Poland)
Gregory Kuperberg	University of California, Davis
Dmitriy Leykekhman	N/A
Gerhard Michler	Essen University (Germany)
Dmitry Novikov	Purdue University
Brendan Owens	McMaster University (Canada)
Edward Waymire	Oregon State University
Warren Weckesser	Colgate University

2004-2005 Visiting Program Faculty

(Includes the faculty members' home institutions.)

James Belk	N/A
Nelia Charalambous	N/A
William Harris	Georgetown College
Sunethra Weerakoon	University of Sri Jayewardenepura (Sri Lanka)

Faculty Leaves

Louis Billera	Sabbatical leave, spring 2005
Indira Chatterji	Leave, spring 2005
Etienne Rassart	Leave, 2004–2005

Faculty Promotions / Title Changes

Irena Peeva to associate professor

Staff Changes

Reorganization

In spring 2003, Arletta Havlik, Michelle Klinger, Brenda Smith, Cathy Stevens, and Colette Walls worked together to develop a reorganization plan that would accommodate the reduction of one staff position. The majority of job duties previously held by Brenda Smith were redistributed to Arletta Havlik (technical typist/registrar), Michelle Klinger (undergraduate coordinator/webmaster), and Cathy Stevens (teaching program coordinator). In addition, Linda Clasby (assistant to the chair), Gayle Lippincott (accounts representative), Donna Smith (graduate field coordinator), and Colette Walls (administrative manager) each picked up additional job tasks as a result of the reorganization. Gayle Lippincott's non-academic human resource duties were distributed to Cathy Stevens and Linda Clasby, thus freeing up Gayle's time to concentrate on proposal submissions, accounting, and reporting. Brenda's position was eliminated effective July 1, 2003. Most of the changes and adjustments took place during summer 2003, and the reorganization proved to be a success. Each of the employees affected by the reorganization should be recognized for their openness to change, willingness to learn new skills, and sense of commitment to the mathematics community at Cornell.

Systems Administrator

Allen Back resigned as half-time systems administrator effective June 1, 2004. He will remain in the department in his role as senior lecturer. Many thanks to Allen for his hard work over the past year in securing our system and handling the various tasks associated with system maintenance.

In spring 2004, the College of Arts and Sciences agreed to increase our systems administrator position from half time to full time. We are pleased to announce that Steve Gaarder joined us on May 19, 2004 in the new full-time position. Steve has extensive experience in a broad spectrum of computing technologies with an emphasis on Linux/Unix and networking. He comes to us from a local biotechnology company, Gene Network Sciences (GNS), where he administered the network, servers, and desktops running Linux and Windows 2000 and XP. In a previous position at Moldflow Corporation (formerly C-Mold), he managed a complex, heterogeneous network including systems from every major Unix vendor, Linux, Windows NT, and Macintosh.

Workforce Planning

The university has been undergoing a workforce planning effort that will, in some cases, change the way financial business is transacted at the university. The purpose of this exercise is to streamline procedures and cut administrative costs. Some colleges have opted for a standardized approach to workforce planning that centralizes all financial transactions into the college and removes all accounting personnel from the department level into a central administrative service center. An administrative service center approach has been mandated by the President's Office and requires some form of centralized service for each unit.

Over the past year, the College of Arts and Sciences has been working to create a plan that complies with this mandate in a less dramatic fashion than some of the other colleges. The College of Arts and Sciences' model hopes to maintain flexibility and keep decision making at the department level. Colette Walls, administrative manager for the Mathematics Department, served as facilitator last summer for a planning committee in the early stages of development for the Arts College model. Throughout the fall semester, she also served as facilitator for the College of Arts and Sciences Workforce Planning Steering Committee and participated in writing the proposal and business plan that was submitted by the Arts & Sciences Dean's Office to the University Controller's Office at the end of December 2003. That proposal was accepted, and the Arts & Sciences Administrative Service Center (ASC) will open for business on July 1, 2004.

The Arts & Sciences model differs from other colleges in that each department or program in the college will be able to write a separate and unique contract with the ASC, choosing different levels of service based on departmental interests or needs. The only requirement for every department is that transactions involving procurement cards be processed outside the department. Mathematics Department procurement card purchases and transactions documentation will be handled outside of the department (in the A&S ASC) by the beginning of the coming academic year. Over time, we may contract for additional financial transaction services outside the department if it appears that the arrangement suits the needs of the department.

Gifts and Endowments

As always, we appreciate the kindness and generosity of alumni and other friends of mathematics. During the 2003–2004 academic year, designated donor gifts increased the principal of various department endowments. In addition, the department received some unrestricted gift donations, which are used to supplement departmental activities for the mathematics community at Cornell. In many cases, contributions were received in response to the department newsletter, *Math Matters*. By distributing this newsletter, we hope to keep our many friends current on department activities. If you would like to be added to the newsletter mailing list, please contact Catherine Stevens at cls15@cornell.edu.

2003-2004 Contributors

Gilbert H. Alexander
Barry Belkin
Jerome Blackman
David Boochever
Robert G. Chipkin
Sean Cleary
Alan Cody
R. Keith Dennis
Michael DuPont
Jill Fisch
Fay Gayle-Hickle
Philip M. Ginsberg
Joshua I. Goldberg
Louis Joseph Gross
Harvey Jerome Iglarsch
Andrew Joskow
Ira G. Kastrinsky
David M. Keranen
Alison Klugherz Kideckel
Joseph M. Lazur
Lillian Jane Lee
Charlotte Lin
Shirley McGrath
Jean-Pierre Gustave Meyer
Julian P. Ochrymowych
Brian Merrick O'Connor
Gerald Porter
Thomas Rishel
John Rosenthal
Henry K. Schenck
David Wall

Endowments

The department is thankful to alumni, friends and family who support the department endowments. Without their generosity, we would be unable to provide many of the offerings that make our department unique.

We instituted new departmental teaching awards for graduate students and faculty in 2001. We would like to endow the **Teaching Award for Graduate Students** so that a generous prize can accompany it.

The **Colloquium Endowment Fund** was instituted to invite distinguished scientists to speak at the Oliver Club seminars. James E. Oliver founded the Oliver Club in January 1891 as the Mathematical Club of Cornell University. (Oliver Club talks are announced at www.math.cornell.edu/~oliver/.)

The **Eleanor Norton York Endowment** was established in honor of Eleanor Norton York, with the intent of recognizing outstanding graduate students in both Astronomy and Mathematics. The income from this endowment is used to provide annual prizes to continuing graduate students.

The **Faculty Book Endowment** is dedicated to providing the Cornell community with immediate access to one of the world's finest collections of mathematics books and publications.

The **Israel Berstein Memorial Fund** was established in honor of Israel Berstein, who was a professor in this department from 1962 through 1991. The memorial fund has as its central purpose helping young mathematicians in the field of topology.

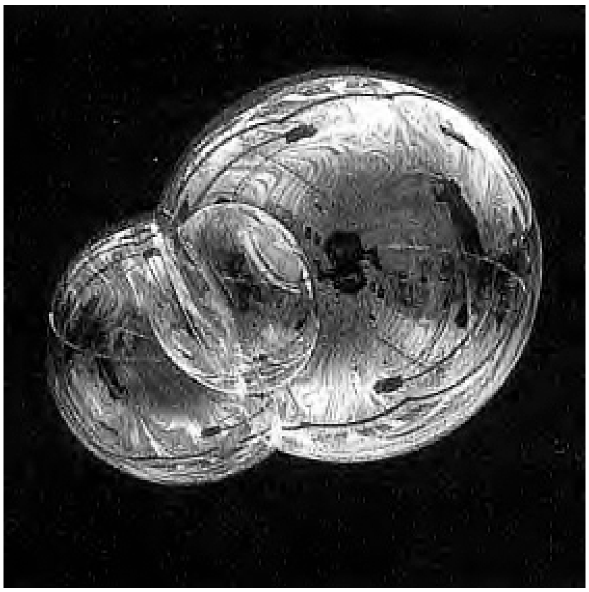
The **Logic Endowment** was established as the direct result of a very generous gift from a former Cornell undergraduate. This endowment seeks to actively support promising logic students.

The **Robert John Battig Endowment** was established by his parents after his untimely death. Robert was awarded a January 1998 Ph.D. in mathematics. The fund provides an annual prize to an outstanding continuing graduate student in mathematics at Cornell.

The **Michael D. Morley Senior Prize in Mathematics** is presented to an Ithaca High School student who has excelled in mathematics and who has demonstrated originality and innovative power in mathematics.

VIGRE

The 2003-2004 academic year was the fourth year of the Mathematics Department's 5-year NSF VIGRE grant, which provides $500,000 a year to support postdocs, graduate students, undergraduate research, and our outreach activities to high school students. This NSF funding is supplemented by generous matching funds from the College of Arts and Sciences and the Cornell Graduate School.



At the Math Explorers Club, Ithaca High School students can find out what blowing bubbles, like those shown above, has to do with math.

VIGRE Postdocs

Fall 2003 saw the arrival of the final incoming class of postdocs under our VIGRE grant: Hsiao-Bing Cheng, a 2003 Ph.D. from Harvard; Paul Jung, a 2003 Ph.D. from UCLA; and Sarah Day, a 2003 Ph.D. from Georgia Tech. Sarah spent her first year on leave at the Free University in Amsterdam. In addition to the VIGRE postdocs, there are two NSF postdocs: Nathan Broaddus, a 2003 Ph.D. from Columbia; and Kevin Wortman, a 2003 Ph.D. from University of Chicago. No new postdocs were hired this year to start in 2004 because their last two years would go beyond the end of our VIGRE grant. Indeed, the College of Arts and Sciences is providing support for the third year for postdocs starting in fall 2003.

VIGRE Fellows

Fall 2003 saw the arrival of the last class of VIGRE fellows: Joshua Bowman (St. Olaf), Matthew Noonan (Hampshire College), Chris Lipa (North Carolina State), Jonathan Needleman (Oberlin College), and Anael Verdugo (Caltech). Verdugo is supported by a two-year fellowship from the Graduate School. Although we could not admit any actual VIGRE fellows for fall 2004, the Graduate School allowed us to borrow against future fellowships to admit four VIGRE fellows in anticipation of the continuation of VIGRE funding: Owen Baker (North Carolina State), Raymond Cassella (SUNY Stony Brook), Gregory Muller (Rutgers), and Gwyneth Whieldon (St. Mary's College of Maryland).

Summer Fellowships

As in the past, the VIGRE grant provided support for graduate students in the summer. In the summer of 2003, 20 students were supported (VIGRE fellows in their first three years plus five other advanced students). Summer fellowship support is important to allow students to broaden their knowledge of mathematics or to concentrate on their thesis research.

Support for Undergraduate Research

Two undergraduates received small grants over the summer of 2003 to do research. Tom Maloney worked with Veit Elser of Physics to apply a technique called the difference map to the assignment problem and the traveling salesman problem. Joe Otchin, working with Anil Nerode, read papers on the historical development of game theory in preparation for a senior thesis on that topic. The VIGRE grant also provided support for two Cornell undergraduates to participate in the Cornell REU and for graduate students to work with two of the projects. (See p. 40 for a description of REU.)

VIGRE Interdisciplinary Colloquium

In fall 2003 the Interdisciplinary Colloquium turned its focus inward, offering talks on current research in the Mathematics Department. The speakers and the titles of their talks were:

Reyer Sjamaar, *The spectrum of the sum of two Hermitian matrices*

Yulij Ilyashenko, *Planar differential equations, Hilbert's 16th problem and analytic foliations*

Edward Swartz, *What is a matroid?*

John Guckenheimer and **Robert Strichartz** rounded out the semester by giving a presentation on experimental mathematics.

The VIGRE colloquium took a break for two months while faculty recruiting brought a large number of job candidates to Cornell. In the last five weeks of the semester we had three talks:

John Smillie, *Can complex analysis be useful in understanding higher dimensional dynamical systems?*
Louis Billera, *Face rings of polytopes, continuous splines and combinatorial intersection homology*
Yuri Berest, *Huygens' principle and Hadamard's conjecture*

In between these was **Steve Strogatz**'s Math Awareness Month lecture: *Sync* (p. 44).

Outreach Activities

VIGRE funds contribute significantly to the department's outreach activities in the form of the Math Explorer's Club (p. 42) and the Ithaca High School Senior Seminar (p. 43).

The Future of VIGRE

NSF officials tell us there is no such thing as a renewal of a VIGRE grant, but they will consider applications by universities with existing grants, so we will be submitting a proposal for a new VIGRE grant. Two months ago we were optimistic that we would be one of 6 winners in the competition. The recent NSF-sponsored meeting *Dialog 2004* held in Washington, DC, has chilled our optimism. Nine schools have VIGRE grants expiring in the summer of 2004: Arizona, University of Colorado, Columbia, Harvard, North Carolina State, Penn State, University of Washington, and University of Wisconsin. From these schools and new schools applying for VIGRE grants there will be 2–3 awards beginning in fall 2004. In the summer of 2005, twelve more VIGRE sites will end their final years: Brown, UCLA, Chicago, Cornell, Duke, University of Illinois at Chicago, University of Illinois at Urbana, Michigan, NYU, Purdue, and Texas A&M. These schools, unsuccessful applicants from the previous year, and some new schools, probably two dozen in all, will compete for 3–4 awards to begin in 2005.

Our VIGRE grant has been very successful, passing its third year review without any demerits. We are hard at work now developing a proposal with new initiatives at all levels. The idea is to write a complete draft by the end of June, let it age over the summer, put the finishing touches on it when school resumes in late August and upload it to FastLane for the September 16, 2004 deadline.

Faculty Research and Professional Activities

Grant and contract expenditures for the fiscal year 2003–2004 totaled $2,718,212. This included 42 grants and contracts from federal, state and private agencies awarded to 33 faculty members. Faculty submitted 19 new grant proposals, 6 of which (shown below) have been funded to date by the National Science Foundation.

P.I.	Amount	Duration	Title of Grant
Yulij Ilyashenko	$138,515	7/1/04–6/30/07	Simplified Versions of Hilbert's 16th Problem and Related Topics in Complex Dynamics and Analytic Foliations
Gregory Lawler	$678,872	6/1/04–5/31/09	Random Walks and Scaling Limits
Camil Muscalu	$105,448	6/1/04–5/31/07	Paraproducts with Flag Singularities
Irena Peeva	$400,780	8/1/04–7/31/09	Careers: Free Resolutions
Ravi Ramakrishna	$150,000	7/1/04–6/30/07	Variation of Selmer Groups
Al Schatz & Lars Wahlbin	$360,000	8/1/03–7/31/06	Algorithms & Numerical Analysis for Partial Differential Equations

Graduate and Postdoctoral Training in Probability Theory

Six Cornell probabilists — Richard Durrett, Gregory Lawler, and Laurent Saloff-Coste from Mathematics and Philip Protter, Sidney Resnick, and Gennady Samorodnitsky from OR&IE — have received a substantial five-year grant from the Infrastructure Program in the Division of Mathematical Sciences at the National Science Foundation. Much of the funding, which is in addition to the individuals' research grants, will be used to provide support for the two dozen graduate students doing research in probability. The grant provides enough money each year for six full-year research assistantships, which will be shared equally by the departments of Mathematics and OR&IE. Each year there will be 10–12 travel awards of $500 for graduate students and 4–6 distinguished visitors who will give one or two talks and interact with graduate students.

There will be two hot topics workshops each year. A typical workshop will last from Sunday morning to mid-day Tuesday and involve eight speakers and eight young researchers. The first two conferences were organized by Phil Protter (*Mathematical Finance*, March 26–27, 2004) and Laurent Saloff-Coste (*Markov Chains and Random Algorithms*, May 9–11, 2004, see p. 31). Visit the grant web page (www.orie.cornell.edu/stats/stats.php3) for more information about these and future conferences.

Each summer, a two-week Summer School in Probability and its Applications will be held at Cornell University. Greg Lawler is organizing the first summer school for July 10–24, 2005. There will be three main speakers who will present a course of approximately six 1-1/2 hour lectures. The main lectures will be held in the mornings (two of the three lecturers lecturing each day) with some other lectures in the late afternoons. The early afternoons will remain free for informal interactions. There will be 20–30 grants covering local expenses for graduate students and young researchers. Visit www.math.cornell.edu/~lawler/sum2005.html for details.

The choice of speakers and topics for our workshops will be done in consultation with an advisory board that consists of representatives of most of the major probability groups throughout the country — David Aldous, David Heath, Thomas Kurtz, Claudia Neuhauser, Charles Newman, Yuval Peres, Simon Tavare, and Ruth Williams.

Faculty Editorships

Dan Barbasch, editor of *Proceedings of the AMS*

Yuri Berest, editor of the *Journal of Nonlinear Mathematical Physics* (Sweden)

Louis Billera, editorial board of *Discrete and Computational Geometry* and *Journal of Algebraic Combinatorics*

Robert Connelly, editor of *Beiträge zur Algebra und Geometrie*

Richard Durrett, associate editor of *Journal of Theoretical Probability, Notices of the American Mathematical Society* and *Stochastic Processes and their Applications*

Eugene Dynkin, advisory boards of *Mathematics in Operations Research* and *Probability Theory and its Applications*

Leonard Gross, editorial boards of *Journal of Functional Analysis*, *Reviews of Mathematical Physics*, *Potential Analysis*, *Soochow Journal of Mathematics*, *Revista Colombiana de Matemàticas* and advisory board of *Methods of Functional Analysis and Topology*

John Guckenheimer, editor of *Journal of Experimental Mathematics*, *SIAM Journal of Applied Dynamical Systems*, *Moscow Mathematical Journal*; and managing editor of *DSWeb*

Yulij Ilyashenko, editor of *Functional Analysis and its Applications*, *Dynamical and Control Systems*, *Ergodic Theory and Dynamical Systems*, *Proceedings of the Moscow Mathematical Society* and *Mathematical Enlightenment*; editor-in-chief of *Moscow Mathematical Journal*

Gregory Lawler, associate editor of C*ombinatorics, Probability and Computing*

Anil Nerode, associate editor of the *Annals of Mathematics and Artificial Intelligence*, the *Journal of Pure and Applied Algebra*, the *Computer Modeling and Simulation* Journal, and the *International Journal of Hybrid Systems*

Michael Nussbaum, associate editor of *Annales de l'Institut Henri Poincaré* and *Statistics and Decisions*

Laurent Saloff-Coste, editor of *Mathematische Zeitschrift*; associate editor of *Probability Theory and Related Fields*, S*tochastic Processes and their Applications*, *ESAIM: Probability and Statistics*, and the *Journal of Theoretical Probability*

Shankar Sen, editorial board of the *Journal of the Ramanujan Mathematical Society*

Richard Shore, editor of *Studies in Logic and the Foundations of Mathematics* (North-Holland book series)

Birgit Speh, editor of the *New York Journal of Mathematics* and the *Journal of Representation Theory*

Michael Stillman, algebraic geometry editor for the *Proceedings of the American Mathematical Society*

Robert Strichartz, executive editor of *Journal of Fourier Analysis and Applications*

Lars Wahlbin, editor of *Mathematics of Computation*

James West, editorial board, *Fundamenta Mathematicae*

2003-2004 Faculty Publications

Dan Barbasch, *A reduction theorem for the unitary dual of unitary groups* (to appear).

Yuri Berest, Pavel Etingof, and Victor Ginzburg, *Cherednik algebras and differential operators on quasi-invariants*, Duke Math. Journal **118** (2003), 279–337.

Yuri Berest and George Wilson, *Differential isomorphism and equivalence of algebraic varieties*; in Proceedings of the Oxford Symposium "Topology, Geometry and Quantum Field Theory" in honor of the 60th birthday of Graeme Segal (U. L. Tillman, ed.), LMS Lecture Notes Series **308**, 2004.

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Tara Brendle and Benson Farb, *Every mapping class group is generated by 6 involutions*, J. Algebra (to appear).

Joan Birman and **Tara Brendle,** *Braids and knots*; in Handbook of Knot Theory (W. Menasco and M. Thistlethwaite, eds.) (to appear).

Kenneth Brown, *Semigroup and ring theoretic methods in probability*, Fields Institute Communications **40** (2004), 3–26.

James Belk and **Kenneth Brown,** *Forest diagrams for elements of Thompson's group F*, Internat. J. Algebra Comput. (to appear).

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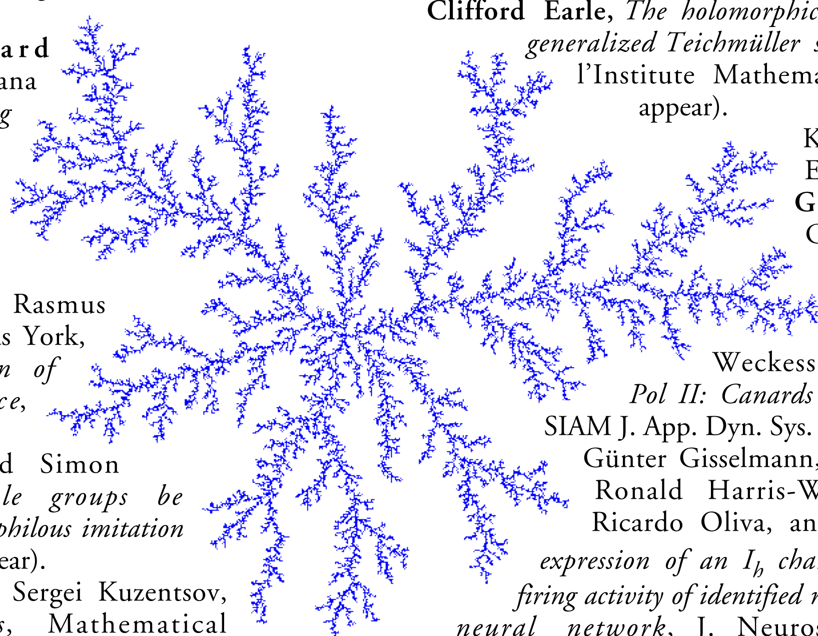

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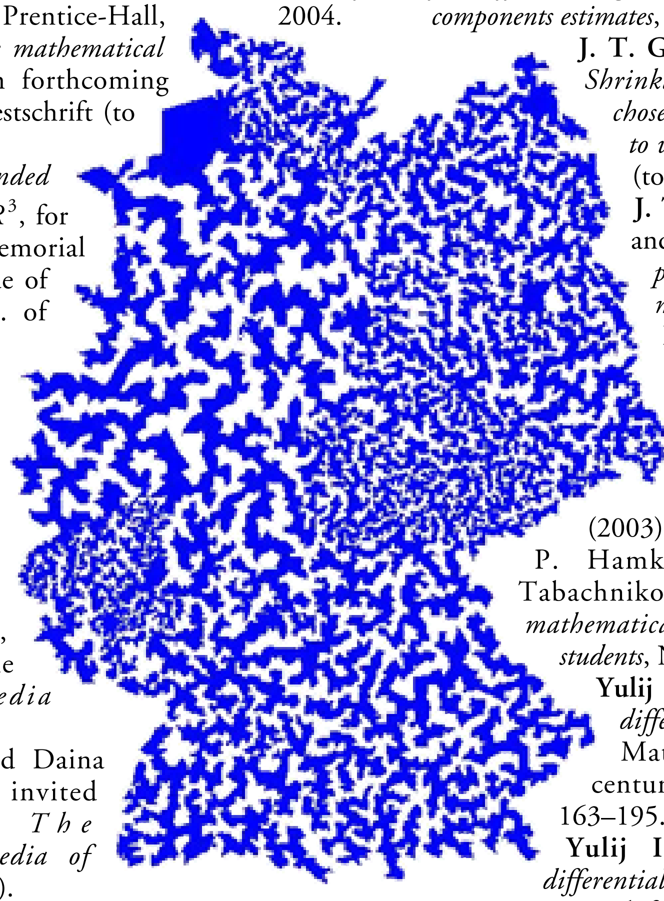

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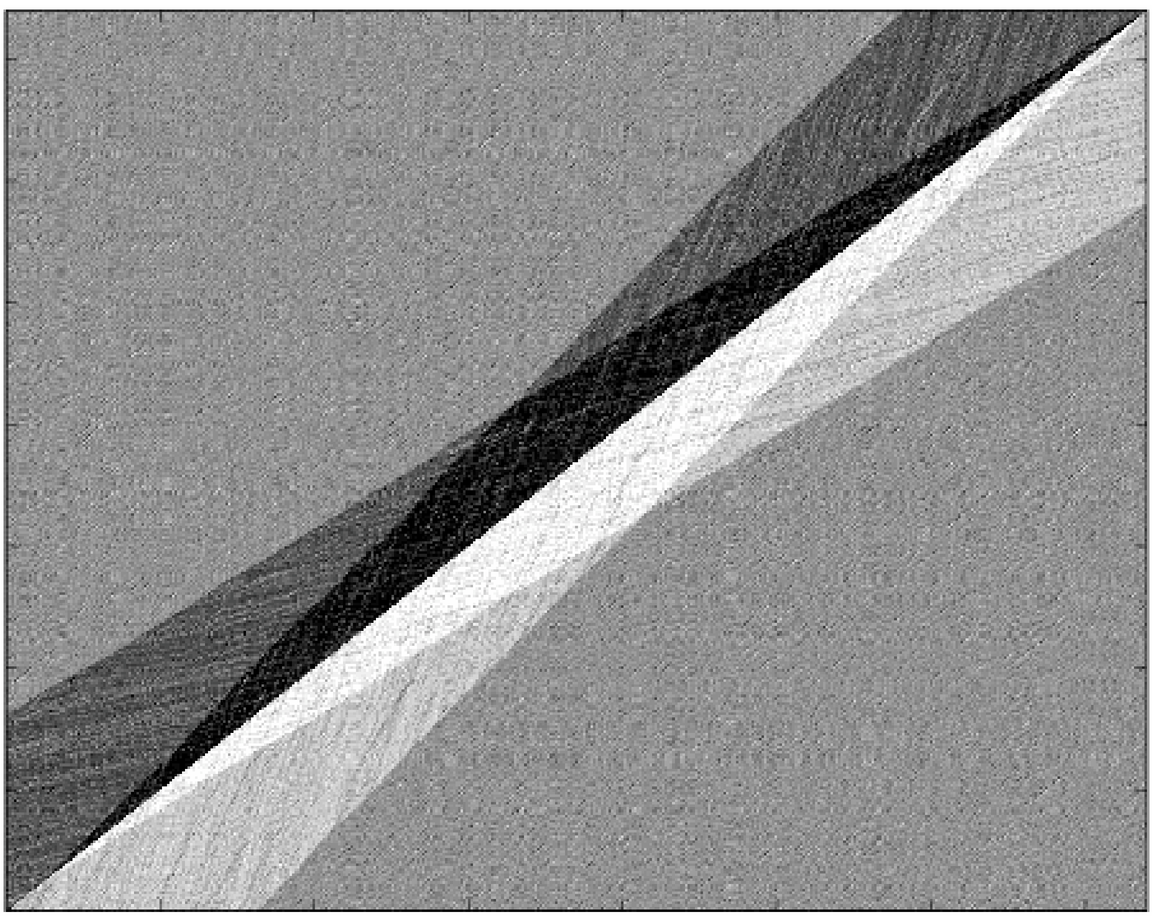


Teaching Program

During the 2003–2004 academic year, the Mathematics Department offered 128 courses in 219 lectures and 153 recitations to 5,751 students, generating 22,522 credit hours. (See pp. 16–17.) While students were drawn from every college at Cornell, the majority came from the College of Agriculture & Life Sciences (13%), Arts & Sciences (31%), Engineering (42%) and the Graduate School (10%). (See pp. 17–18 for a complete list of courses with enrollments and credit hours.)

The Department of Theoretical & Applied Mechanics (T&AM) supported instructors for 12 lectures of the engineering calculus sequence. The remaining 207 lectures were supported by the Mathematics Department. The following faculty from T&AM and other scientific departments at Cornell contributed to the success of our teaching program in 2003–2004 by teaching lectures of engineering mathematics: K. Bingham Cady (T&AM), Hsiao-Dong Chiang (Electrical Engineering), P. C. Tobias de Boer (Mechanical Engineering), T. Michael Duncan (Chemical Engineering), Chung-Yuen Hui (T&AM), James Jenkins (T&AM), Subrata Mukherjee (T&AM), Steven Strogatz (T&AM) and Z. Jane Wang (T&AM). Since T&AM shares the teaching of engineering calculus, they are accredited with 50% of the credit hours for MATH 190/191 in the fall and MATH 293-294 for the year, amounting to 3,702 credits for 2003–2004.

The 2003–2004 teaching program was supported by 103 teaching assistants and associates, who served as TA instructors for 35 lectures of MATH 105, 111, 112, 171, 191, and 192, as instructors for 2 freshman writing seminars (MATH 189), as recitation TAs for our freshman- and sophomore-level courses, and as graders for our upper-level undergraduate and first-year graduate courses. The department received support for 8 full-time TAs from T&AM, 2.5 full-time TAs from the Center for Applied Mathematics (CAM), 1.5 full-time TAs from the Knight Writing Program for MATH 189 and our Writing-in-the-Major (WIM) courses MATH 403 and 451, 1 half-time TA from the Computer Science Department for MATH 335/COM S 480, and 1 half-time TA from Ecology & Evolutionary Biology for BIOEE/MATH 362. The majority of our TAs are mathematics graduate students, but in the 2003–2004 academic year 15 TAs were from T&AM, 10 from CAM, 4 from Statistics, 3 from Education, 2 from Applied and Engineering Physics, 2 from Electrical Engineering, 1 from Biological Statistics and Computational Biology, 1 from Civil and Environmental Engineering, 1 from Computer Science and 1 from Neurobiology.

During summer session 2003, the Mathematics Department offered 11 courses to 223 students, generating 839 credit hours. (Enrollments and credit hours are displayed in the table below.) The following short-term visitors taught during summer 2003: Marwan Awartani (Birzeit University, Israel), Thomas Barr (Rhodes College), David Brown (Ithaca College), Gary Cochell (Culver-Stockton College), Craig Johnson (Marywood University), Thomas Pfaff (Ithaca College), and V. Lee Turner (Southern Nazarene University).

Visiting Program

Each year, the Visiting Program attracts mathematics professors on leave from small colleges around the country. Program participants are appointed half time to teach two (usually identical) courses each semester. While at Cornell, participants are free to attend classes, participate in seminars, conduct research and interact with Cornell faculty and students. Mercedes Franco (Ph.D. 2003, Cornell University), Stephen Hilbert (Ithaca College, New York), Mark McClure (University of North Carolina), and John Thurber (Eastern Oregon University) participated in this year's visiting program. We appreciate their efforts.

Summer Session 2003 Course Enrollment Statistics

Course and Title		Format	Instructor	Enroll	Cr Hrs	Session
103	Mathematical Explorations	Lecture	R. Terrell	10	30	3-week
103	Mathematical Explorations	Lecture	Barr	27	81	6-week
109	Precalculus Mathematics	Lecture	Alfors, D. Brown	16	48	6-week
111	Calculus I	Lecture	Awartani	31	124	6-week
171	Statistical Theory and Applications	Lecture	Back	18	72	6-week
191	Calculus For Engineers	Lecture	Pfaff	21	84	6-week
192	Calculus For Engineers	Lecture	C. Johnson	19	76	6-week
293	Engineering Mathematics	Lecture	Stubna (T&AM)	29	116	8-week
294	Engineering Mathematics	Lecture	Turner	33	132	8-week
311	Introduction to Analysis	Lecture	Bailey	5	20	6-week
332	Algebra and Number Theory	Lecture	Cochell	14	56	6-week

Academic Year Course Enrollment Statistics

Course and Title		Format	Instructor	Enroll	Cr Hrs	Term
103	Mathematical Explorations	Lecture	Franco, Solomon	49	147	Fall 2003
103	Mathematical Explorations	Lecture	Franco, McClure, Morley	60	180	Spring 2004
105	Finite Mathematics for the Life and Social Sciences	Lecture	Saloff-Coste	124	372	Fall 2003
106	Calculus for the Life and Social Sciences	Lec/Sec	Sjamaar	175	525	Spring 2004
111	Calculus I	Lecture	M. Terrell (czar), McClure, Odifreddi	346	1,384	Fall 2003
111	Calculus I	Lecture	Hilbert	105	420	Spring 2004
112	Calculus II	Lecture	Fickus (czar), Rajagopalan	182	728	Fall 2003
112	Calculus II	Lecture	Andrea, Barbasch (czar), Rajagopalan, Thurber	166	664	Spring 2004
121	Honors Calculus I	Lec/Sec	J. West	13	52	Fall 2003
122	Honors Calculus II	Lec/Sec	Dindos, Vladimirsky	38	152	Fall 2003
122	Honors Calculus II	Lec/Sec	McClure	11	44	Spring 2004
135	The Art of Secret Writing	Lecture	Smithline	19	57	Spring 2004
171	Statistical Theory & Application In The Real World	Lec/Sec	Bendikov, Nussbaum, Thurber	92	368	Fall 2003
171	Statistical Theory & Application In The Real World	Lec/Sec	Bendikov, Hwang	86	344	Spring 2004
189	FWS: The Dementia of Demension	Seminar	(TA)	17	51	Fall 2003
189	FWS: The Dementia of Demension	Seminar	(TA)	18	54	Spring 2004
190	Calculus For Engineers	Lec/Sec	Schatz	21	84	Fall 2003
191	Calculus For Engineers	Lec/Sec	Broaddus, Chiang (EE)*, Connelly (czar), Csima, Jung, Okoudjou, Smithline, Z. Wang (T&AM)*	304	1,216	Fall 2003
191	Calculus For Engineers	Lec/Sec	Okoudjou	9	36	Spring 2004
192	Calculus For Engineers	Lec/Sec	Andrea, Bux, Cady (czar; T&AM)*, Cheng, de Boer (M&AE)*, Duncan (T&AM)*, Gasharov, Mukherjee (T&AM)*, Peeva, Protsak	498	1,992	Fall 2003
192	Calculus For Engineers	Lec/Sec	Gasharov, Meadows	310	1,240	Spring 2004
213	Calculus III	Lec/Sec	Perez	29	116	Fall 2003
213	Calculus III	Lec/Sec	Jung	11	44	Spring 2004
221	Linear Algebra and Differential Equations	Lec/Sec	Mitrea, Protsak, Vogtmann, Zaffran	130	520	Fall 2003
221	Linear Algebra and Differential Equations	Lec/Sec	Protsak, Strichartz, Zaffran	83	332	Spring 2004
222	Multivariable Calculus	Lec/Sec	R. Terrell, Zaffran	59	236	Fall 2003
222	Multivariable Calculus	Lec/Sec	Back, Speh	76	304	Spring 2004
223	Theoretical Linear Algebra and Calculus	Lec/Sec	Strichartz	17	68	Fall 2003
224	Theoretical Linear Algebra and Calculus	Lec/Sec	Ramakrishna	16	64	Spring 2004
231	Linear Algebra	Lecture	R. Terrell	30	90	Spring 2004
275	Elementary Probability for Applications	Lecture	Durrett	14	42	Spring 2004
293	Engineering Mathematics	Lec/Sec	Stillman, Strogatz (T&AM)*, R. Terrell	345	1,380	Fall 2003
293	Engineering Mathematics	Lec/Sec	Jenkins (T&AM)*, B. Smith	479	1,916	Spring 2004
294	Engineering Mathematics	Lec/Sec	Hui (T&AM)*	319	1,276	Fall 2003
294	Engineering Mathematics	Lec/Sec	Swartz, R. Terrell	383	1,532	Spring 2004
311	Introduction to Analysis	Lecture	Chalykh	36	144	Spring 2004
321	Manifolds and Differential Forms	Lec/Sec	Sjamaar	17	68	Fall 2003
323	Introduction to Differential Equations	Lecture	Wahlbin	13	52	Fall 2003
332	Algebra and Number Theory	Lecture	Billera	18	72	Fall 2003
335	Introduction to Cryptology (also COM S 480)	Lecture	Swartz	29	87	Spring 2004
336	Applicable Algebra	Lecture	Berest, Protsak	53	212	Spring 2004
356	Groups and Geometry	Lecture	J. West	7	28	Spring 2004
362	Dynamic Models in Biology (also BIOEE 362)	Lecture	Guckenheimer & Ellner (E&EB)	41	123	Spring 2004
401	Honors Seminar: Topics In Modern Mathematics	Lecture	Ramakrishna	10	40	Spring 2004
403	History of Mathematics	Lecture	Taimina	10	40	Spring 2004
408	Mathematics In Perspective	Lecture	Vogtmann	6	24	Spring 2004
413	Honors Introduction to Analysis I	Lecture	Dindos, Ilyashenko	63	252	Fall 2003
413	Honors Introduction to Analysis I	Lecture	Dindos	10	40	Spring 2004
414	Honors Introduction to Analysis II	Lecture	Smillie	27	108	Spring 2004
418	Function Theory of One Complex Variable	Lecture	Mitrea	11	44	Spring 2004
420	Differential Equations and Dynamical Systems	Lec/Sec	Guckenheimer	9	36	Fall 2003
420	Differential Equations and Dynamical Systems	Lec/Sec	Perez	17	68	Spring 2004
422	Applied Complex Analysis	Lec/Sec	Gross	27	108	Spring 2004
424	Wavelets and Fourier Series	Lecture	Okoudjou	11	44	Spring 2004
425	Numerical Analysis and Differential Equations	Lecture	Vladimirsky	5	20	Fall 2003
428	Introduction To Partial Differential Equations	Lecture	Wahlbin	18	72	Spring 2004
431	Linear Algebra	Lecture	Chalykh	31	124	Fall 2003
432	Introduction to Algebra	Lecture	Chase	15	60	Spring 2004
433	Honors Linear Algebra	Lecture	Michler, Sen	36	144	Fall 2003
434	Honors Introduction to Algebra	Lecture	Dennis	30	120	Spring 2004
441	Introduction to Combinatorics I	Lecture	Billera	24	96	Fall 2003
442	Introduction to Combinatorics II	Lecture	Billera	9	36	Spring 2004
451	Euclidean and Spherical Geometry	Lecture	Henderson	14	56	Fall 2003
452	Classical Geometries	Lecture	Chatterji	7	28	Spring 2004

Course and Title		Format	Instructor	Auditors	Enroll	Cr Hrs	Term
453	Introduction to Topology	Lecture	Lawler		15	60	Fall 2003
454	Introduction to Differential Geometry	Lecture	Henderson		13	52	Spring 2004
471	Basic Probability	Lecture	Saloff-Coste		29	116	Fall 2003
472	Statistics	Lecture	Nussbaum		7	28	Spring 2004
486	Applied Logic (also COM S 486)	Lecture	Nerode		13	52	Spring 2004
490	Supervised Reading and Research	Lecture	Faculty		6	36	Fall 2003
490	Supervised Reading and Research	Lecture	Faculty		6	36	Spring 2004
500	College Teaching	Lecture	M. Terrell		4	4	Fall 2003
505	Educational Issues In Undergraduate Mathematics	Lecture	Henderson	3	6	24	Spring 2004
507	Teaching Secondary Mathematics	Lecture	Solomon		8	32	Spring 2004
508	Mathematics For Secondary School Teachers	Lecture	Solomon		0	0	Fall 2003
508	Mathematics For Secondary School Teachers	Lecture	Solomon		1	6	Spring 2004
611	Real Analysis	Lecture	Gross	6	18	72	Fall 2003
612	Complex Analysis	Lecture	Earle		12	48	Spring 2004
614	Topics In Analysis	Lecture	Saloff-Coste	2	8	32	Spring 2004
615	Mathematical Methods In Physics	Lecture	Gross		11	44	Fall 2003
617	Dynamical Systems	Lecture	Ilyashenko	5	12	48	Fall 2003
619	Partial Differential Equations	Lecture	Wahlbin	2	7	28	Fall 2003
620	Partial Differential Equations	Lecture	Cheng	2	3	12	Spring 2004
621	Measure Theory and Lebesgue Integration	Lecture	Bendikov	2	11	44	Fall 2003
622	Applied Functional Analysis	Lecture	Bendikov	6	7	28	Spring 2004
628	Complex Dynamical Systems	Lecture	Smillie		4	16	Spring 2004
631	Algebra	Lecture	Chase		6	24	Fall 2003
632	Algebra	Lecture	Sen	4	6	24	Spring 2004
634	Algebra	Lecture	Peeva	1	12	48	Spring 2004
650	Lie Groups	Lecture	Sjamaar	2	6	24	Fall 2003
651	Introductory Algebraic Topology	Lecture	J. West	2	4	16	Spring 2004
652	Differentiable Manifolds I	Lecture	B. Smith		9	36	Fall 2003
661	Geometric Topology	Lecture	Brendle	7	5	20	Fall 2003
671	Probability Theory I	Lecture	Lawler	12	23	92	Fall 2003
672	Probability Theory II	Lecture	Dynkin	3	12	48	Spring 2004
674	Introduction To Mathematical Statistics	Lecture	Nussbaum		9	36	Spring 2004
675	Statistical Theories Applicable to Genomics	Lecture	Hwang		9	36	Fall 2003
681	Logic	Lecture	Csima	5	4	16	Spring 2004
703	Topics in the History of Mathematics	Lecture	Nerode	1	5	20	Spring 2004
711	Seminar In Analysis	Seminar	Kumagai	2	6	24	Fall 2003
712	Seminar In Analysis	Seminar	Kemp	4	5	20	Spring 2004
717	Applied Dynamical Systems (also T&AM 776)	Lecture	Guckenheimer	8	13	52	Spring 2004
728	Seminar In Partial Differential Equations	Seminar	Schatz		6	24	Spring 2004
731	Seminar In Algebra	Seminar	Berest	5	5	20	Fall 2003
732	Seminar In Algebra	Seminar	Barbasch		4	16	Spring 2004
735	Topics In Algebra	Lecture	Swartz	4	8	32	Fall 2003
737	Algebraic Number Theory	Lecture	Sen		4	16	Fall 2003
739	Topics In Algebra	Lecture	Michler	7	3	12	Fall 2003
739	Topics In Algebra	Lecture	Peeva		4	16	Spring 2004
751	Seminar In Topology	Seminar	Bux	3	5	20	Fall 2003
752	Seminar In Topology	Seminar	Brendle	6	4	16	Spring 2004
755	Topology and Geometric Group Theory Seminar	Seminar	N/A		1	4	Fall 2003
756	Topology and Geometric Group Theory Seminar	Seminar	N/A		1	4	Spring 2004
757	Topics In Topology	Lecture	Vogtmann	5	3	12	Fall 2003
758	Topics In Topology	Lecture	Chatterji	3	7	28	Spring 2004
761	Seminar In Geometry	Seminar	Meadows	8	3	12	Fall 2003
762	Seminar In Geometry	Seminar	Thurston		4	16	Spring 2004
767	Algebraic Geometry	Lecture	Stillman		22	88	Fall 2003
771	Seminar In Probability and Statistics	Seminar	N/A		2	8	Fall 2003
772	Seminar In Probability and Statistics	Seminar	N/A		3	12	Spring 2004
777	Stochastic Processes	Lecture	Schweinsberg	6	16	64	Fall 2003
778	Stochastic Processes	Lecture	Lawler	9	16	64	Spring 2004
781	Seminar In Logic	Seminar	Shore	9	5	20	Fall 2003
782	Seminar In Logic	Seminar	Shore	10	4	16	Spring 2004
783	Model Theory	Lecture	Shore	2	4	16	Spring 2004
784	Recursion Theory	Lecture	Csima	3	4	16	Fall 2003
790	Supervised Reading and Research	Ind Stud	Faculty		19	114	Fall 2003
790	Supervised Reading and Research	Ind Stud	Faculty		21	126	Spring 2004

TOTALS	Courses	Enroll	Dept* Cr Hrs	Total Cr Hrs
Fall Semester	58	3,090	10,230	12,208
Spring Semester	70	2,661	8,590	10,314
Academic Year	128	5,751	18,820	22,522

* The Department of Theoretical and Applied Mechanics shares in the teaching of engineering calculus and is accredited with 50% of the credit hours for MATH 190/191 in the fall and MATH 293 and 294 for the year; the remainder are accredited to Mathematics.

Teaching Awards

Christopher Francisco, a fifth-year graduate student in the Mathematics Department, was selected to receive a John M. and Emily B. Clark Distinguished Teaching Award from the College of Arts and Sciences. The award was presented at a college faculty meeting on May 11th. Recipients of the Clark Award demonstrate their devotion to teaching, student counseling and development of new courses and new methods of instruction. Christopher is among the very best teaching assistants in the College of Arts and Sciences. He is the eighth graduate student in the department to receive the Clark Award since 1993. Recent recipients include Kathryn Nyman (2001) and David Brown (2000).

Recipients of three Department Teaching Awards were announced at the department's annual holiday party. The *Senior Faculty Teaching Award* was given to **Maria Terrell** in recognition of her enthusiastic and innovative teaching of calculus, as well as her excellent training and supervision of teaching assistants. The *Junior Faculty Teaching Award* was given to **Dan Zaffran** in recognition of his excellent and inspiring teaching. The *Graduate Student Teaching Award* was given to **Dan Ciubotaru** in recognition of the high quality of his teaching, especially in engineering mathematics.

The Good Questions Project

Through an NSF-funded, proof-of-concept project, that we call the Good Questions Project, a group of faculty and graduate students have begun to learn about and develop materials that foster inquiry-based learning and teaching in freshman calculus. Over the past two years, we have experimented with developing the kind of good questions that raise the visibility of key ideas, that instructors find attractive enough to use in their teaching, that provoke student discussion and debate, and the kind of practices related to asking questions that can promote or stifle classroom interaction. Faculty members Robert Connelly, David Henderson, Robert Strichartz, and Maria Terrell were involved with the project. Graduate students Bryant Adams, Jim Belk, Nelia Charalmbous, Bradley Forrest, Chris Franciso, Lee Gibson, Marita Hyman, Carla Martin, Jason Martin, Everilis Santana-Vega, Steve Sinnott, Briggita Vermesi, Treven Wall, and Harrision Zhou worked to develop the materials and test them last fall.

Imagine a classroom where the instructor pauses every fifteen minutes or so to ask a highly conceptual multiple choice question. Students think about the question independently and vote through an anonymous polling system. As the instructor uses that feedback to start to assess the class's understanding, students are encouraged to discuss their answers with a student sitting nearby, preferably someone who thinks about the problem differently. As the room erupts with inquiries of "What did you think?" and "Why did you think that?" and replies of "Well, I'm not sure, but I think…," the instructor listens. Students share their reasoning, argue its validity, and work together as they think more deeply about what the question means and how mathematical ideas might apply. The instructor calls for a re-vote, shares the result with the class, and asks for someone who changed her mind to the correct answer to share with the class what caused her to change her mind. In the space of four to five minutes the instructor has provoked students to think, surveyed students' votes, listened to students' conversations, and obtained valuable insight into students' thinking about key concepts. At the same time, students have wondered, conjectured, reasoned, argued, justified, refined their mathematical reasoning and understanding, and shared that new understanding with the class. This is the Good Questions approach.

We used the Good Questions approach in MATH 111 in fall 2003. Surveys, interviews, and videotaping revealed that there were very strong differences and patterns in the ways instructors used good questions. Instructors used the questions 3–4 days per week, 1–2 days per week, or rarely/never. Good questions were designed to assess and to engage students in progressively deeper levels of mathematical thinking and reasoning. Most instructors used *quick checks* most frequently in their teaching, but some instructors used *probing* and *deep* questions much more than usual. Some instructors regularly followed each good question with peer discussion, some instructors only occasionally used peer discussion, and others explained the answers to the class themselves with little or no peer discussion.

We analyzed effects on student performance on exams by identifying questions as "conceptual" problems and "routine." Our results are very preliminary, but the data suggests that students in sections with many deep questions and heavy peer instruction had significantly higher test scores. Unfortunately, only two instructors were in that group and both sections had higher than average SAT math profiles, so the results, while intriguing, are not significant. The students in sections that used good questions almost every day and made heavy use of peer instruction consistently out-performed on both routine and conceptual parts of all three prelims and showed dramatically stronger overall performance on the comprehensive final exam. Data analysis continues.

The Good Questions project is preparing an NSF full materials development proposal to seek support to continue materials development and testing. We are eager to see what trends emerge when a larger number of students and instructors at diverse institutions are using the materials.

Curriculum Changes

Starting in the fall of 2003, we changed the format of MATH 105, *Finite Mathematics for the Life and Social Sciences*. Instead of a large lecture twice a week and a small section twice a week taught by a teaching assistant, students now attend 3 weekly lectures of at most 30 students. Faculty or instructional teaching assistants teach these lectures.

In the spring, we introduced three new courses: MATH 135, *The Art of Secret Writing*; MATH 275 *Elementary Probability for Applications*; and MATH 335, *Introduction to Cryptology*. The first two courses are designed for students who would like to learn some interesting mathematics while fulfilling the quantitative reasoning distribution requirement in the Arts College. MATH 335 was designed with the help of the computer Science Department and discusses the mathematics relevant to computer security.

Next year, we plan to experiment with a new format in MATH 111, *Calculus I*, in the spring term. Instead of 4 lectures per week, the classes will meet 3 times, but with a number of weekly workshops taught by advanced undergraduate students. Students in MATH 111 will be free to attend any of these workshops. If this experiment is successful we will consider continuing with this format in the fall semester in MATH 111 and possibly extending it to MATH 112.

Mathematics/Engineering Liaison

Robert Connelly, Irena Peeva, Kenneth Brown, and Birgit Speh from Mathematics and Richard Rand and Steven Strogatz from Theoretical & Applied Mechanics formed the Mathematics Engineering Liaison Committee in 2003–2004. After several meetings, the committee decided to revise the content of the first three engineering mathematics courses, MATH 191, 192, and 293. There was a consensus among those who have taught the courses that entering students are reasonably well prepared for at least the first half to two-thirds of the material covered in MATH 191. At the other end (MATH 293), first-semester sophomore Engineering students are unfortunately not receiving a thorough introduction to differential equations. In addition, the sequence MATH 191-192-293 is largely out of sync with most calculus sequences at peer institutions, creating difficulties in giving proper credit for many entering students and placement for entering and transfer students.

Consequently, the committee has revised the syllabi of MATH 191, 192, and 293 so that MATH 191 will be a standard second-semester calculus course (starting this summer), MATH 192 will be a third-semester calculus course (starting this fall), and MATH 293 will be a reasonable introduction to differential equations (starting spring 2005). Those students who have not had a good first-semester calculus sequence will be required to take such a course in the summer, before taking MATH 191. Our expectation is that very few students will be in this situation.

All these changes have been presented to the College Curriculum Governing Board in Engineering and the Educational Policy Committee in the Arts College. Both have given us a "green light," and we expect that these changes will be a great benefit for the students.

Instructional Support

Mathematics Instructional Computer Lab

Classes making major use of the Mathlab this year were *Statistics* (MATH 171), *Multivariable Calculus* (MATH 222), *Differential Equations and Dynamical Systems* (MATH 420), and *Honors Introduction to Algebra* (MATH 434). To a lesser degree *Mathematical Explorations* (MATH 103), *Honors Calculus II* (MATH 122), *Euclidean and Spherical Geometry* (MATH 451), and *Teaching Secondary Mathematics* (MATH 507) also made use of the lab.

The weekly Friday afternoon MATH 171 recitations continued with the same format as last year — using the "work on a computer lab" theme that was started last year. Classes for both the fall and spring were generally filled to capacity. MATH 171 could be considered as the primary user of the Math lab over the past year.

Paul Young, working under Prof. Dennis, held classes for the computer algebra GAP programming component of MATH 434 twice a week approximately every other week. This year, the GAP programming component of the course became a requirement instead of being optional as it was when it was introduced last year.

Dr. Back and Professor Speh made use of Maple and Matlab for MATH 222, giving students hands-on experience at visualizing and manipulating both 2D and 3D plots. Use of previously developed experimentation worksheets for Maple 7 continued in the course. Licenses have already been obtained for the current release of Maple 9, and the worksheets will need to be tested for compatibility with the current release. Deployment of Maple 9 on the Mathlab computers and testing of the worksheets will occur over summer 2004.

It is anticipated that MapleTA will gain in popularity as a web-based mathematical teaching tool, which would require connectivity improvements in the Mathlab to increase network performance. Adding more network ports (we currently have only one) and converting hubs to switches will help to accomplish this task. This would provide the ability for web-based applications to run more quickly and efficiently.

Red Hat Linux 7.3 was removed from service in the Mathlab, and Red Hat Linux 9 was installed on all of the 1.4GHz Pentium 4 machines. It is expected that using Red Hat Linux 9 as the primary Linux platform will provide an increased level of security within the Mathlab.

Early in fall 2003, a new HP LaserJet 4200tn printer was purchased to replace the old HP LaserJet 4Si printer. Four 2.6GHz Pentium 4 Windows XP machines were also purchased. Three of the machines were purchased to replace the three older Gateway 266MHz Windows NT machines. In addition, due to the lack of need for Mac-based mathematical software; the small number of Mac machines that remained in the Mathlab were removed. One Mac PowerPC 7500/100 G3 (333MHz) remains in the Mathlab. It is the demonstration machine used by an instructor and tied into the LCD projector. Aside from that single machine, the Mathlab is now exclusively a Windows / Linux environment.

Mathematics Support Center

An academic support wing of the Mathematics Department, the Mathematics Support Center provides free one-on-one and small-group tutoring, workshops and review sessions on topics of common concern in mathematics, approximately 50 brief printed capsules on various mathematical topics, and advice, encouragement, and referrals for students. Although the center focuses on support of introductory courses, it employs both undergraduates and postgraduates (about 8 each year) of diverse backgrounds and provides some limited tutoring even in upper-level courses. During the 2003–2004 academic year, in addition to paid tutors, several volunteers donated their time and expertise: Professor Emeritus Roger Farrell, Harry Bowman, Matthew Rhodes, and Joey Palin. Douglas S. Alfors directs the operations of the MSC and coordinates its efforts with the instructors of the introductory calculus sequence. The MSC is located on a main thoroughfare of Malott Hall and is consequently quite visible and accessible to students. We have several tutoring areas that are sufficiently separated from one another to address privacy and noise issues, yet are not so widely separated that we lose contact with someone who is working on something. Our reception area can adequately accommodate students who are waiting for their turn to be tutored, and we have a couple of sites that work nicely for small groups. The small library of texts that we maintain can be accessed easily by tutors and tutees, and mathematics computer programs provide additional support when needed. We anticipate having a more visible web presence soon and plan to replace some antiquated computer equipment. We maintain weekday hours of service (10:00 AM–5:00 PM), as well as Sunday hours (1:30–5:30 PM).

Learning Strategies Center

The Learning Strategies Center (LSC) provides academic support in a variety of subjects across campus, including biology, chemistry, physics, genetics, economics, writing, study skills, mathematics and statistics. The mission of the LSC is to provide academic assistance to students during their transition from high school students to accomplished Cornell students. Studies have shown that students who successfully complete their freshman year generally go on to graduate from Cornell. Therefore, most of the LSC's efforts are directed to supporting large, primarily freshmen, courses.

In the 2003–2004 academic year, the LSC provided academic support for MATH 105, 106, 111, and 112. Support included respective supplemental courses MATH 005, 006, 011, and 012. Each supplemental course consisted of a ninety-minute weekly lecture, held on either Sunday, Monday or Wednesday evening, which reviewed material covered in the parent course, with an emphasis on problem solving and prelim preparation. In addition, the supplemental course instructors and their assistants provided extensive tutoring hours.

Under the direction of Patricia Alessi, the LSC Statistics Lab in the Center for Learning and Teaching provided support for MATH 171 and other undergraduate statistics courses. The tutor-staffed lab was open four evenings per week, equipped with statistical software and problem sets for the courses supported. During the 2004–2005 academic year, support will continue to be provided as described above for MATH 105, 106, 111, 112, and 171.

Graduate Program

The American Mathematical Society rates Cornell's Mathematics Department among the top in the country. The U.S. News and World Report placed Cornell ninth in the nation in its 2002 national ranking of graduate mathematics programs.

The Ph.D. program included 77 graduate students during the 2003–2004 academic year, including three non-degree students. Class representatives were Russ Woodroofe (sixth year), Melanie Pivarski (fifth year), Franco Saliola (fourth year), Henri Johnston (third year), Bradley Forrest (second year) and Jonathan Needleman (first year). Treven Wall served as the graduate and professional student representative.

Graduate students play an essential role in all aspects of the department: teaching, research, mentoring of undergraduates and community outreach programs.

Graduate Student Recruitment

Josh Bowman, Heather Heston, Sarah Koch, Mia Minnes, Jay Schweig, and **Treven Wall** planned and executed a very successful Prospective Graduate Student Weekend March 11–13, 2004. This was the third year for the Prospective Weekend, which takes many hours of planning to arrange housing, meetings with students and faculty, and events. Everyone agrees that it is well worth the effort and resources.

In the coming year, we will have 75 graduate students. The entering class this fall will consist of eleven new Ph.D. students. **Artem Pulemotov** was awarded a two-year fellowship, and **Ingvar Sigurjonsson** and **Zhigen Zhao** have been awarded one-year fellowships from the Cornell Graduate School to cover full tuition and stipend. **Owen Baker, Raymond Cassella, Gregory Muller,** and **Gwyneth Whieldon** have been awarded VIGRE fellowships under the Graduate School's VIGRE trainee fellowship. **John Workman** was awarded an NSF fellowship and the DOD award. **Noam Horwitz** and **Robyn Miller** are transferring to Mathematics from the Center for Applied Mathematics and Neurobiology, respectively. **Guan-Yu Chen,** a non-degree student for the past year working with Professor Saloff-Coste, will also join the department as a full-time graduate student.

The department will host two non-degree students in 2004–2005: **Laure Fumex,** University of Paris VII (France), will be supported under an exchange agreement with the Cornell Abroad EDUCO Center in Paris. **Christophe Garban** from the University of Paris will be working with Professor Gregory Lawler.

Graduate Student Awards

The *Robert John Battig Graduate Prize* was awarded to **James Belk** and **Harrison Zhou**. Recipients of the Battig Prize are graduate students in mathematics at Cornell who have passed the A exam (typically in their second year of study). Any such graduate student is eligible regardless of social or financial background. James is a student of Ken Brown. Harrison has joint committee chairs J. T. Gene Hwang and Michael Nussbaum. Jim and Harrison are outstanding researchers and have been excellent students throughout their degree work. Both Jim and Harrison will graduate in August 2004.

Hutchinson Fellowships were awarded to **Melanie Pivarski** and **Jason Martin**, providing one semester of relief from teaching to allow them to work on their thesis problems. Established in 1947 by Genevra Barrett Hutchinson to honor her husband John Irwin Hutchinson and his long teaching career in the Mathematics Department, Hutchinson fellowships are awarded annually to mathematics graduate students who have done outstanding work as teaching assistants or as students in the graduate program. Accordingly, it is given to students who have completed three years of study and are not in their final year. Melanie is working with Robert Connelly and Jason with Ravi Ramakrishna. Melanie and Jason are outstanding researchers and teachers, and they have been very active in outreach programs run by the Department of Mathematics.

The *Eleanor Norton York Award* was awarded to **Matija Cuk** in Astronomy and **Farkhod Eshmatov** in Mathematics. The York Award was established by friends of Eleanor York, who died of cancer in 1993. Each year a student in the Mathematics Department and a student in the Astronomy Department, in which Eleanor was employed, are selected to receive this award. Recipients are chosen from those in the middle of their graduate education on the basis of their achievements to date to encourage them to have even more success in the future. Farkhod is a third-year student of Yuri Berest.

Two graduate students received teaching awards this year. **Christopher Francisco** was awarded the *Clark Distinguished Teaching Award* by the College of Arts and Sciences, and **Dan Ciubotaru** was presented the *Graduate Student Teaching Award* at the Mathematics

Department's annual holiday party. For more information, see p. 19.

Outreach Activities

Graduate students play a key role in the department's outreach activities. Sharad Goel (CAM), **Kristin Camenga, Treven Wall,** and **Sunny Fawcett** participated in the Math Explorers Club. Sharad Goel and Rick Durrett led a module on learning probability by playing games. Kristin Camenga introduced students to concepts of graph theory by playing a number of games. Treven Wall led a module on secret codes with Lawren Smithline, and Sunny Fawcett showed students how to have fun with geometry.

Sharad Goel, **James Belk,** and **Jay Henniger** organized the Ithaca High School Senior Seminar under the direction of Rick Durrett. The three graduate students led workshops on game theory, topology, and combinatorics, respectively.

Evgueni Klebanov, Mia Minnes, Jonathan Needleman, Melanie Pivarski, Maria Sloughter, and **Treven Wall** conducted a probability workshop for Expanding Your Horizons, to teach 6th, 7th, and 8th grade girls that math can be fun. More on these outreach activities can be found in Community Outreach, p. 42–45.

Department Colloquia

Devoted to expository talks on current research areas, the Olivetti Club is organized entirely by graduate students, and most of the speakers are graduate students. **Drew Armstrong** and **Franco Saliola** served as organizers in the fall and **Christopher Hardin** and **Matthew Noonan** organized talks in the spring. In addition, **Jason Martin** organized the Number Theory and Algebraic Geometry Seminar, **Lee Gibson** ran the Graduate Probability Seminar, and **Mia Minnes** and **Kristin Camenga** conducted the Graduate Teaching Seminar. In all, forty graduate students gave 120 talks in department seminars this year. (See Department Conferences and Seminars, pp. 31–39.)

Preparing Future Professors

The Preparing Future Professors program continues to prepare graduate students for the professorate while attracting attention from outside administrative agencies. The College of Arts and Sciences Dean's Office provided funding for the program this year, and Dr. Maria Terrell served as director.

Cornell graduate students gave talks to mixed audiences of faculty and students at nearby colleges and universities, an experience that afforded participants the opportunity to talk about their work in ways that anticipate both professional meetings and job searches, while providing understandable and enjoyable colloquia for undergraduates in our region. The graduate student speakers were also able to see firsthand how faculty roles and student expectations at other campuses can vary widely from those here at Cornell. Graduate students **Eduardo Carta, Lee Gibson**, and **Sarah Koch** coordinated the following talks:

Jay Schweig: *The Tutte polynomial of a planar graph* (Hamilton College)
Ben Chan: *Random harmonic series* (Hamilton College)
Spencer Hamblen: *Perfect numbers* (Hamilton College and Hobart & William Smith); *Magic squares* (Hobart & William Smith)
Lee Gibson: *There and back again, or The ubiquitous concept of recurrence* (SUNY Cortland)

Other Graduate Student Activities

Graduate students were active in attending conferences and giving off-campus research presentations at meetings and specialized conferences. Samplings of these activities follow:

Kristin Camenga gave talks at the Binghamton AMS meeting and the combinatorics seminar at SUNY Binghamton.

Christopher Francisco spoke at the Route 81 Conference on Commutative Algebra and Algebraic Geometry at Syracuse (*Some computational work on the multiplicity conjecture*), October 2003, and at the Joint Meetings in Phoenix (*Some computational work on bounding multiplicities*), January 2004. With Irena Peeva, Chris co-organized an AMS Special Session, entitled *Syzygies and Hilbert functions,* at the AMS Southeastern Section Meeting at Florida State University.

Todd Kemp gave an invited lecture at Ecole Normale Superieure in Paris. This summer Todd will be working with Bill Arveson at University of California, Berkeley on collaborative research. He also designed and taught MATH 712 (*Compact Operators on Hilbert Space*). The course was taken by eight students and was extremely successful.

JaEun Ku gave two talks, *A least-squares FEM* and *A first order least-squares FEM* at the Finite Element Circus at Cornell and the University of Pittsburgh, respectively.

Yi Lin gave two invited talks at the Geometry seminar at SUNY at Stony Brook and a Symplectic seminar at Toronto University.

Antonio Montalban gave three invited talks: *Embedding jump upper semilattices into the Turing degrees*, Annual meeting of the Association of Symbolic Logic, Chicago, June 2003, and Computability and Logic Workshop, Heidelberg, Germany, June 2003; *Generalized high degrees have the complementation property,* Southeastern Logic Symposium, Gainesville, FL, March 2004.

Melanie Pivarski attended the Binghamton Sectional meeting, the AMS/MAA joint meetings in Pheonix and the Seminar in Stochiastic Processes in Vancouver, Canada.

Roland Roeder spent the past academic year in France working with his advisor John Hubbard. He presented a talk at a conference/workshop at l'Institut Henri Poincaré in Paris on *Holomorphic surgery*, gave a colloqium at LUMINY, the CNRS Institute in Marseille, gave two seminars at the Université de Provence, and a mini-colloquim, *Geometrie et topologie en basse dimension*.

Harrison Zhou gave the talk *Infinitely divisible approximations to I.I.D. density estimation experiments* at the Joint Statistical Meeting, San Francisco.

Graduate Student Publications

Bryant Adams and Hod Lipson, *A universal framework for self-replication*; in Proceedings of ECAL 2003. (Also presented as a poster at the conference.)

Christopher Francisco, *Minimal graded Betti numbers and stable ideals*, Comm. Algebra **31** no. 10 (2003), 4971–4987.

Christopher Francisco, *Almost complete intersections and the Lex-plus-powers conjectur*e, J. Algebra **276** no. 2 (2004), 737–760.

Noam Greenberg and **Antonio Montalban**, *Embedding and coding below a 1-generic degree*, Notre Dame Journal of Formal Logic (to appear).

Yi Lin and his advisor Reyer Sjamaar had a joint paper accepted by the Journal of Symplectic Geometry.

Antonio Montalban, *Embedding jump upper semilattices into the Turing degrees*, Journal of Symbolic Logic **68** no. 3 (2003), 989–1014.

Roland K. W. Roeder, *On Poincaré's fourth and fifth examples of limit cycles at infinity*, Rocky Mountain J. Math. **33** no. 3 (2003), 1057–1082.

T. E. Evans, B. I. Rapoport and **Roland K. W. Roeder**, *Explicit calculations of homoclinic tangles in tokamaks*, Phys. Plasmas **10** no. 9 (2003), 3796–3799.

J. T. Gene Hwang and **Harrison Zhou**, *Minimax estimation with thresholding and its application to wavelet analysis*, Ann. Stat. (to appear).

Doctoral Degrees

August 2003

Matthew Horak
Mapping Class Subgroups of Outer Automorphism Groups

B.S. (1996) Northern Arizona University
Committee: Vogtmann, Hatcher, Brown
First Position: Postdoctoral position, Trinity College

Abstract: Let Σ be a punctured orientable surface with fundamental group isomorphic to the free group F_n, and let $\Gamma(\Sigma)$ denote the mapping class group of Σ. By considering all punctured surfaces and all possible identifications of $\pi_1(\Sigma)$ with F_n, we construct a covering of Culler-Vogtmann Outer space by Teichmüller spaces of punctured surfaces. We prove that the nerve of this cover is contractible, so the action of $\mathrm{Out}(F_n)$ on the nerve gives rise to a spectral sequence converging to the homology of $\mathrm{Out}(F_n)$. The E^1 page of this spectral sequence is given by the homology of simplex stabilizers. We prove that the stabilizer of a vertex in the nerve is the mapping class group of a surface, and we identify stabilizers of higher-dimensional simplices with stabilizers of sets of conjugacy classes in F_n.

We then proceed to examine the E^∞ page of the above spectral sequence. By using Harer's homology stability theorems for mapping class groups to analyze the d^1 map, we find a bound on the dimension of the subspace of $H_*(\mathrm{Out}(F_n);\mathbf{Q})$ generated by the stable rational mapping class homology. Motivated by the question of whether $\Gamma(\Sigma) \to \mathrm{Out}(F_n)$ is nontrivial on homology, we summarize the constructions of known nontrivial stable homology classes for mapping class groups in terms of three different graph complexes. We then give chain maps between these complexes and several chain complexes that compute the homology of $\mathrm{Out}(F_n)$.

Samuel Hsiao

Quasisymmetric Functions and Flag Enumeration in Eulerian Posets

M.S. Special (2001) Cornell University
B.S. (1995) Haverford College
Committee: Billera, Stillman, Brown
First Position: NSF postdoctoral fellow, University of Michigan

Abstract: We study the algebraic and enumerative combinatorial aspects of Eulerian posets and their quasisymmetric generating functions. These generating functions span the so-called peak algebra Pi, which originated with Stembridge's theory of enriched *P*-partitions. Remarkably, many constructs in the peak algebra that are natural in the context of enriched *P*-partitions are also important from the viewpoint of flag enumeration. For example, we show that the fundamental basis of peak functions arising from enriched *P*-partitions of chains is precisely the basis that is needed to properly encode the *cd*-index, a common invariant in the study of convex polytopes and Eulerian posets. As another example, the descents-to-peaks map, which relates the ordinary and enriched theories of *P*-partitions, turns out to be important for computing the flag-enumerative information of an oriented matroid based on that of the underlying matroid.

We introduce a family of Eulerian posets, called posets of signed order ideals. Each of these posets is defined by appropriately "signing" a distributive lattice. We establish that the flag-enumerative relationship between a poset of signed order ideals and its underlying distributive lattice is completely analogous to that between an oriented matroid and its underlying matroid. Furthermore, we show that these posets are EL-shellable, they have non-negative *cd*-indices, and their quasisymmetric generating functions enumerate the enriched *P*-partitions of certain labeled posets.

We analyze the (external) Hopf algebra structure on Pi, showing it to be dual to the concatenation Hopf algebra on letters of odd degree. Consequently, Pi is freely generated as a commutative algebra. Upon closer inspection of the generators, we find that Pi is free as a module over the ring of Schur *Q*-functions. Much of our analysis builds on basic properties of a monomial-like basis for the peak algebra, as well as a recursively-defined basis of eigenvectors for the descents-to-peaks map. We give a simple criterion, in terms of this monomial basis, for determining when an element of Pi is symmetric.

Fernando Codá Marques

Existence and Compactness Theorems on Conformal Deformation of Metrics

M.S. (1999) Instituto Nacional de Matemática Pura e Aplicada (Brazil)
B.S. (1999) Universidad Federal de Alagoas (Brazil)
Committee: Escobar, Strichartz, Walhbin
First Position: Associate researcher, Instituto Nacional de Matemática Pura e Aplicada (Brazil)

Abstract: We prove that the set of solutions to the classical Yamabe equation, on a compact Riemannin n-manifold with positive Yamabe quotient, not necessarily locally conformally flat, is compact in the C^2 topology. Since we use the Positive Mass Theorem in the proof, we restrict ourselves to the cases $4 \leq n \leq 7$. In the cases $n = 6,7$, we also prove that the Weyl tensor has to vanish at a blowup point. The proofs are based on a careful blowup analysis of solutions. Given a compact n-manifold with umbilic boundary, $n \geq 9$, finite $Q(M,\partial M)$, such that the Weyl tensor does not vanish identically on ∂M, we show the existence of conformally related metrics with zero scalar curvature and constant mean curvature on ∂M. The proof of this result is based on an asymptotic analysis of the Sobolev quotients of explicitly defined test functions, using conformal Fermi coordinates.

Rebecca Schuller

Learning from Disparate Data Sources

M.S. Special (2002) Cornell University, Mathematics
M.S. Special (2002) Cornell University, Computer Science
B.A. (1998) Grinnell College
Committee: Nerode, Hartmanis, Caruana
First Position: Senior analyst, ALPHATECH, Inc.

Abstract: Many endeavors require the integration of data from multiple data sources. One major obstacle to such undertakings is the fact that different sources may vary considerably in the way they choose to represent their data, even if their data collections are otherwise perfectly compatible. In practice, this problem is usually solved by a manual construction of translations between these data representations, although there have been some recent attempts at supplementing this with automated algorithms based on machine learning methods.

This work addresses the problem of making classification predictions based on data from multiple sources, without

constructing explicit translations between them. We view this problem as a special case of the problem of multitask learning: Both intuition and much empirical work indicate that learning can be improved by attacking multiple related tasks simultaneously; however, thus far, no theoretical work has been able to support this claim, and no concrete definition has been proposed for what it means for two learning tasks to be "related."

In this work, we introduce a general notion of relatedness between tasks, provide the standard sort of information complexity bound for learning such tasks, and give general conditions under which this bound is an improvement over the standard single task learning result.

Finally, we apply these results to the problem of learning from disparate data sources. We give a decision tree learning algorithm for this problem for a particular type of data source disparity and demonstrate its empirical success on real data sets.

January 2004

Janet Best
The Mathematics of Ecological Competition

M.S. (2000) University of Wisconsin
B.A. (1989) Princeton University
Committee: Durrett, Guckenheimer, Castillo-Chavez
First Position: Postdoctoral position, MBI - Ohio State University

Abstract: In this thesis we use systems of ordinary differential equations to model competition between species. Coexistence is not possible in the competitive system; we ask when it can be embedded in a higher dimensional system with a predator species such that coexistence can occur in the full system. The form of predation is the same for all prey species up to parameter values.

Under suitable conditions on the parameters in the model, we prove that for three prey species and one predator species a sufficient condition for coexistence is that, as the density of a prey species approaches zero, the limit of the ratio of the per capita predation to the species density equals zero.

The proof constructs a function that blows up at the boundary and decreases along solutions near the boundary, thereby pushing solutions into the interior of the domain. It follows that after a finite amount of time, solutions are bounded away from the boundary and coexistence occurs.

May 2004

Shawn Walker
Shift Techniques and Multicover Inequalities on Colored Complexes

B.S. (1999) University of Georgia
Committee: Billera, Connelly, Dennis
First Position: undecided

The combinatorics of regular cell complexes, such as convex polytopes and simplicial complexes, have long been of interest to mathematicians.

We consider the problem of relations between the face counts in simplicial complexes, specifically the class of colored simplicial complexes. We develop two different techniques for studying these face counts.

The first technique, known as shifting, attempts to ascribe a simplified form to each simplicial complex. Given a simplicial complex Δ, we form a new simplicial complex, called the compression of Δ. The compression of Δ maintains the same face counts as Δ, but much of its other structure, both combinatorial and otherwise, is removed. We demonstrate the use of this technique in proving the Kruskal-Katona theorem and develop an analogous shift technique that preserves some of the fine structure contained in colored simplicial complexes.

The second technique, which we investigate, is that of convex or linear analysis. We apply techniques of convex analysis to an appropriate invariant to determine a number of interesting inequalities that relate the face counts of a balanced simplicial complex.

Master of Science Special Degrees

(No Thesis Required)

August 2003

Farkhod Eshmatov, Mathematics
B.S. (1998) Tashkent, Uzbekistan
Committee: Berest, Hubbard, Stillman

Roland K. Roeder, Mathematics
B.A. (2000) University of California, San Diego
Committee: Hubbard, Smillie, Hatcher

Franco Valentino Saliola, Mathematics
B.S. (2000) York University
Committee: Brown, Saloff-Coste, Billera

Brigitta Karola Vermesi, Mathematics
B.A. (1999) Rutgers University
Committee: Lawler, Durrett, Strichartz

Yan Zhang, Mathematics
B.S. (1998) Nankai University
Committee: Sjamaar, Kahn, Stillman

January 2004

Hasanjan Sayit, Mathematics
M.S. (1998) Xingiung University
B.S. (1998) Xingiung University
Committee: Protter, Durrett, Jarrow, Samorodnitsky

Achilleas Sinefakopoulos, Mathematics
B.S. (2001) University of Athens
Committee: Stillman, Peeva, Ramakrishna

Serguei Andreevich Slavnov, Mathematics
Spetzialist (2000) Moscow State University
Committee: Nerode, Morley, Ilyashenko

Yan Zeng, Mathematics
B.S. (1999) Peking University
Committee: Protter, Durrett, Jarrow, Guo

May 2004

David Rabe Benbennick, Mathematics
B.S. (2000) University of Alaska, Fairbanks
Committee: Vogtmann, Hatcher, Brown

William E. Gryc, Mathematics
B.A. (2001) Amherst College
Committee: Gross, Sjamaar, Wahlbin

Henri Louis Alistair Johnston, Mathematics
B.S. (2001) University of Warwick
Committee: Ramakrishna, Sen, Stillman

Treven Parker Wall, Mathematics
B.A. (2000) Baylor University
Committee: Gross, Saloff-Coste, Speh

Undergraduate Program

The Cornell undergraduate program in mathematics in the academic year 2003–2004 included 128 majors (plus 11 conditional acceptances). Bachelors' degrees in mathematics were awarded to 53 students, and we awarded degrees with honors to 17 students, of which 13 were cum laude, 2 magna cum laude, and 2 summa cum laude. James Adler, Andrew Bridy, Guanhan Chew, Peter Clark, Austin Hedeman, Matthew Hirn, Sebastian Mekas, Elizabeth Rach, Matthew Rhodes, Michael Scullard, Sara Slater, Samuel Thompson, and Matthew Wachs graduated cum laude. Michelle Fullwood and Brian Lukoff graduated magna cum laude. Tian Tian Grace Qiu and Asher Walkover graduated summa cum laude.

Undergraduate Awards and Honors

The *Harry S. Kieval Prize in Mathematics* for 2004 was awarded to **Tian Tian Grace Qiu** and **Asher Walkover.** Harry S. Kieval '36 established the Kieval Prize in 1994 to provide an annual award for outstanding graduating senior mathematics majors. The department's honors committee chooses the recipients on the basis of academic performance, the quality and variety of mathematics courses taken, and faculty recommendations.

Grace Qiu was a student of Gregory Lawler. She graduated as a double major with economics, summa cum laude in mathematics, with distinction in all subjects. Grace co-wrote a senior thesis entitled *Counting kneading sequences* under the direction of Rodrigo Perez. This work contained original results and will be published. Grace has accepted an internship at Citigroup in New York City and will attend graduate school in economics at Harvard.

Asher Walkover has done research with Professor Eva Tardos in the Computer Science Department and Professor David Henderson in the Mathematics Department. He earned an honorable mention twice for his performance on the William Lowell Putnam Prize exam. The Putnam exam is given nationwide to undergraduates, and a student must place among the top 70 in the country to receive an honorable mention. Asher graduated in January and is currently working as a software engineer for Google in California.

Michelle Fullwood, Brian Lukoff, and **Tian Tian Grace Qiu** were named *Cornell Merill Presidential Scholoars*. Merrill Presidential Scholars are graduating seniors who have demonstrated outstanding scholastic achievement, strong leadership ability and potential for contributing to society. Each spring semester, 35 scholars, representing approximately 1 percent of the graduating class, are named to receive this honor by the deans of each of Cornell's seven undergraduate colleges. Each Merrill scholar, in turn, recognizes a high school teacher who most inspired his or her scholastic development, as well as a Cornell faculty member who most significantly contributed to his or her college education and experience. Grace Qiu named Prof. John Hubbard.

Michelle Fullwood was a student of Leonard Gross. She graduated magna cum laude in mathematics and magna cum laude in linguistics, with distinction in all subjects. Michelle was also recognized by the Near Eastern Studies Department for excellence in intermediate Arabic. She will return to Singapore to work for the government.

Brian Lukoff was a student of Robert Connelly. He graduated magna cum laude in mathematics and magna cum laude in mathematics education and assessment, with distinction in all subjects. Brian will enter graduate school at Stanford University in Psychological Studies in Education / Learning Sciences and Technology Design.

Grace Qiu and Brian Lukoff were two of the Degree Marshals and Banner Bearers at Cornell's Commencement ceremony, an honor accorded to students with the highest GPA in their college.

Senior mathematics major **Mushfeq Khan** was awarded second place in the Knight Competition for Writing in the Majors for work done in David Henderson's MATH 451 (*Euclidean and Spherical Geometry*). His paper, *Can the Bug Tell Which Manifold?*, discusses how from an intrinsic point of view someone (the bug), who can't walk far, could tell which of 10 possible geometric 2-manifolds it was on — the lower dimensional analog of the problem of determining the shape of our physical universe. The committee praised Mushfeq's paper for "the elegance and clarity of [his] responses to these complex questions." Mushfeq will graduate with an August degree.

Undergraduate Receptions

We conducted two undergraduate receptions this year, one in the fall and one in the spring. Both receptions had multiple functions: advertising courses for the next semester, recruiting interested students into the major, and presenting career information and summer research opportunities in the department. The fall reception focused more on formal presentations, whereas the spring reception was primarily for informal advising of majors regarding fall 2004 courses. The receptions attracted a substantial turnout, both from undergraduates and department faculty. The receptions are likely useful as recruiting tools and may have played some positive role in the recent increase of our majors.

Putnam Competition

The Mathematics Department again fielded a team for the annual William Lowell Putnam competition, a prestigious nationwide mathematics competition, attracting many of the best students in the country. The Cornell team — made up of Asher Walkover, Thitidej Tularak, and Michelle Fullwood — was ranked 21st in the country, a respectable showing. Asher Walkover did exceptionally well, receiving an Honorable Mention. The team was selected from a Putnam study group that met weekly throughout the fall semester under the guidance of professors Kai-Uwe Bux and Martin Dindos.

Mathematical Contest in Modeling

The Mathematical Contest in Modeling (MCM) is an international competition, in which each team of three undergraduates chooses one of two open-ended ("real-world") problems, builds a mathematical model, obtains a solution based on it, and writes a detailed paper proving the feasibility of the team's modeal and solution, all in less than four days.

Four teams represented Cornell at MCM 2004. Jonathan Goldstein, Richard Huddleston, and Stephen Lesko (mathematics) formed a team whose solution was ranked as Meritorious. They worked on the problem "Are Fingerprints Unique," which was posed as follows: It is a commonplace belief that the thumbprint of every human who has ever lived is different. Develop and analyze a model that will allow you to assess the probability that this is true. Compare the odds (that you found in this problem) of misidentification by fingerprint evidence against the odds of misidentification by DNA evidence.

Two other Cornell teams received an Honorable Mention. The teams prepared for the contest together while participating in the Cornell Mathematical Contest in Modeling conducted in November 2003. More information is available at www.math.cornell.edu/~mcm.

Undergraduate Mathematics Club

The undergraduate Mathematics Club, under the leadership of president Joe Otchin, organized a series of talks by Cornell faculty. Attendance for the talks ranged from 10 to 40 people, primarily undergraduates but also faculty and graduate students. The following talks were given:

Steven Strogatz, *Six degrees of separation: small-world networks in science and society*
Shawn Drenning and **Robert Strichartz,** *The geometry of self-similar tiles*
John Guckenheimer, *The birth of chaos: from radio to the beaches of Rio*
Karen Vogtmann, *Geodesics in the space of trees*
Robert Strichartz, John Guckenheimer, and **Alexander Meadows,** *Research Experiences for Undergraduates*
Kai-Uwe Bux, *Ouch, my ruler is too short: a quick and dirty introduction to projective geometry*
Stephen Andrea, *A problem of Ramanujan*
Louis Billera, *What your high school teacher didn't tell you about the discriminant*
A screening of *The Math Life*

Two game nights were organized, involving undergraduates, graduate students, and faculty. Participants enjoyed pizza and played games, such as chess, checkers, bridge, and more.

2004 Kieval Lecture

Jeff Weeks of Topology and Geometry Software and a MacArthur fellow, gave the Harry S. Kieval Lecture on Monday, April 12, 2004 to a packed auditorium of Cornell undergraduates. The lecture, *The Shape of Space*, was held in Malott Hall's Bache Auditorium. Weeks presented the most current experimental and theoretical arguments concerning the curvature and topology of space. Interest in the lecture was so great that over an hour after it was over there were still several students in Bache discussing with the speaker the problems and ideas he had presented.

Senior Theses

Four graduating majors submitted senior theses:

Tian Tian Qiu (with Vorrapan Chandee), *Counting Kneading Sequences* (Supervisor: Rodrigo Perez);
Matthew Hirn, *The Refinability of Step Functions* (Supervisor: Robert Strichartz);
Elizabeth Rach, *Power Law Distributions of Gene Family Sizes* (Supervisor: Richard Durrett);

Asher Walkover, *Greedy Routing* and *Diophantine Approximations* (Supervisor: David Henderson).

These theses were all of high quality, some of them containing publishable results. They will be added to the Mathematics Library's collection of senior theses.

Bachelor of Arts Degrees

Bachelor's degrees were awarded to 53 students, including two in August 2003 and four in January 2004. Two students graduated summa cum laude, two graduated magna cum laude, and thirteen graduated cum laude.

August 2003

Daniel Kupriyenko
Courtney Drew Tompos

January 2004

Thomas Liam Maloney
Diana Pitt
Justin Todd Ross†
Asher Walkover†, *Summa Cum Laude in Mathematics & Kieval Prize in Mathematics*

May 2004

James Haley Adler†, *Cum Laude in Mathematics & Cum Laude in Physics*
Andrew Michael Berry
Alexander George Bomstein†
Andrew Donald Bridy, *Cum Laude in Mathematics*
Paul Louis Brittman†
Philip Devlin Buhler
Deepal S. Chadha
Guanhan Chew†, *Cum Laude in Mathematics & Cum Laude in Physics*
Yong Suk Cho
Steven Joseph Clancy
Peter Michael Clark†, *Summa Cum Laude in Chemistry, Cum Laude in Biological Sciences, Cum Laude in Mathematics, & Cum Laude in Nanotechnology*
Thomas J. De Luca
Cynthia Eng†
Eric A. Engelson†
Michelle Alison Fullwood†, *Magna Cum Laude in Linguistics & Magna Cum Laude in Mathematics*
Jianjin Gui
Charles Alexander Hagedorn
Austin J. Hedeman, *Magna Cum Laude in Physics & Cum Laude in Mathematics*
Matthew J. Hirn, *Cum Laude in Mathematics*
Joon Hoh Huh
David Theodore Kettler
Christopher Kim
Stephen N. Lesko
Andrew Patrick Lieben, *Cum Laude in Chemistry*
Brian Ross Lukoff†, *Magna Cum Laude in Mathematics & Magna Cum Laude in Mathematics Education and Assessment*
Richard Matyas McGrew
Sebastian Mekas†, *Cum Laude in Mathematics*
Soyoung Nam
Omar Ahmed Nayeem†, *Magna Cum Laude in Computer Science*
Joseph William Otchin
Jonathan M. Peress
Barbara Carin Portner
Tian Tian Grace Qiu†, *Summa Cum Laude in Mathematics & Kieval Prize in Mathematics*
Elizabeth Ann Rach, *Cum Laude in Mathematics*
Matthew Elliot Rhodes†, *Cum Laude in Mathematics*
Timothy Blake Ridenour
Kevin Schawinski-Guiton
Michael Scott Scullard†, *Cum Laude in Mathematics*
Eyal Shnaps
Sara Katherine Slater†, *Summa Cum Laude in Physics & Cum Laude Mathematics*
Lisa Marie Stechschulte†
Venkatesh Tiruvallur Thattai
Samuel McIntire Thomson, *Cum Laude in Mathematics*
Matthew Wachs†, *Summa Cum Laude in Computer Science & Cum Laude in Mathematics*
John P. Wasack†
Peishan Wu
Zhong Wei Yeo

† **Distinction in all subjects**

Department Conferences and Seminars

Cornell Topology Festival

The topology/geometry group of the Mathematics Department hosted the forty-second annual Cornell Topology Festival on May 7–10 this year. Now an internationally known tradition, the Festival was founded in part by Paul Olum in 1963 as a small regional conference that celebrated the return of spring and reviewed the outstanding results in topology during the preceding year. In the current era of highly specialized conferences, the Cornell Topology Festival is noteworthy in that — representing the interests of the current faculty — it presents a broad spectrum of current mathematics, usually featuring topics in geometric and algebraic topology, geometric group theory and geometry.

This year saw a continuation of changes in the scope and format of the Festival begun last year with the aid of a three-year NSF grant. The Festival is now a four-day conference, making special outreach efforts to minorities, women, and younger mathematicians, including graduate students. A total of about 50 participants from such groups received support from the Festival. The overall number of participants this year was about 130, a very large increase over last year's number of 85, which, in turn, was a significant increase over that of recent years.

This year, just as last year, the Festival featured eleven one-hour research lectures interspersed with breaks for discussion of results, conjectures and new theorems. As has been the tradition, the talks ranged over a wide area of topology and geometry. However, this year about half of the talks focused on the special area of three-manifold theory. There will be similar areas of emphasis in future Festivals. In addition to the eleven talks, two introductory workshops and a forward-looking panel discussion were featured. The workshops and panel discussion again drew widespread praise from the participants. Other activities included an opening reception, a boat-cruise banquet, two working luncheons, and a picnic. This format is traditional at the Festival and encourages a lively and open exchange of ideas and promotes mathematical collaboration.

This year's featured speakers and their talk titles were: Ian Agol, University of Illinois at Chicago: *Tameness of hyperbolic three-manifolds*; Jeff Brock, Brown University and the University of Texas: *Ending laminations and the Weil-Peterson visual sphere*; Nathan Dunfield, California Institute of Technology: *Does a random 3-manifold fiber over a circle?* John Etnyre, University of Pennsylvania: *Invariants of embeddings via contact geometry*; Rotislav Grigorchuk, Texas A&M University: *Groups of branch type and finitely presented groups*; Peter Kronheimer, Harvard University: *Property P for knots*; Yuli Rudyak, University of Florida: *Category weight and the Arnold conjecture on fixed points of symplectomorphisms*; Rich Schwartz, University of Maryland: *Spherical CR geometry and Dehn surgery*; Dennis Sullivan, City University of New York: *String background in algebraic topology*; William Thurston, Cornell University: *What next?* Zoltan Szabo, Princeton University: *Heegaard diagrams and holomorphic discs*. Ian Agol and Allen Hatcher conducted the two workshops.

The forty-third Cornell Topology Festival will be held in early May 2005. (Next year's schedule will be posted at www.math.cornell.edu/~festival/.)

Finite Markov Chains and Random Algorithms Conference

Jim Fill (Johns Hopkins) and Laurent Saloff-Coste organized the Finite Markov Chains and Random Algorithms Conference, which was held May 9–11, 2004. Featured speakers and their talk titles were: Jim Fill, Johns Hopkins University: *Perfect sampling from the Dickman distribution using coupling into and from the past*; Neal Madras, York University: *Decomposition of Markov chains*; Dana Randall, Georgia Tech: *Two results on slow mixing*; Krishna Athreya, Cornell University: *Irreducibility and stationary measures for Markov chains on intervals*; Alan Frieze, Carnegie Mellon University: *Random walks on random graphs*; Richard Durrett, Cornell University: *Markov chain problems arising from the study of genome rearrangement*; Ravi Kannan, Yale University: *Improved mixing times via blocking conductance*; Prasad Tetali, Georgia Tech: *Concentration, mixing, and transportation*; Eric Vigoda, University of Chicago: *Coupling with the stationary distribution*; David Wilson, Microsoft: *Mixing times of lozenge tiling and card shuffling Markov chains*.

Conference on Stochastic Processes and Analysis to Honor E. B. Dynkin

To honor Prof. E. B. Dynkin on the occasion of his 80th birthday, a Conference on Stochastic Processes and Analysis was held May 9–10, 2004 with a reception the evening of May 9th. Featured speakers and their talk titles were: E. B. Dynkin, Cornell University: *Recent progress on nonlinear PDEs due to new results on* *superdiffusions*; S. E. Kuznetsov, University of Colorado at Boulder: *New tools in the theory of supperdiffusions*; A. V. Skorokhod, Michigan State University: *Measure-valued Markov processes*; R. Z. Khasminskii, Wayne State University: *On averaging and homogenization in non-standard situation*; M. I. Freidlin, University of Maryland and A. D. Wentzell, Tulane University: *Averaging for deterministic and stochastic perturbations*; N. V. Krylov, University of Minnesota: *Quasiderivatives and interior smoothness of harmonic functions associated with degenerate diffusion observed process*; M. B. Malyutov, Northeastern University and D. M. Malyutov, Northeastern University: *Sequential discrimination of Markov chains*; S. A. Molchanov, University of North Carolina: *Spectral bifurcations for random subgraphs of the complete graph.*

Participants (left to right): Seated, A. Skorokhod, E. Dynkin, N. Krylov; kneeling behind, S. Kuznetsov, Ya. Kogan (Bell Labs); standing in front, M. Malyutov, A. Wentzell, M. Freidlin, R. Khasminskii, E. Feinberg (SUNY Stony Brook); standing behind, M. Taksar (U. Missouri, Columbia), S. Molchanov.

A genealogy tree of Dynkin's school was prepared and put on display at the conference. The tree is 4 generations deep and contains over 400 mathematicians from more than 40 countries, most from the United States, Russia and the Ukraine. The genealogy can be found on the web at www.math.cornell.edu/~ebd/.

Analysis Seminar

September 2003

Jun Kigami, Kyoto University: *Local Nash inequality and inhomogeneity of heat kernels*

Takashi Kumagai, Kyoto University and Cornell University: *Function spaces and stochastic processes on fractals*

Victor Nistor, Pennsylvania State University: *Singular integrals on non-compact manifolds and analysis on polyhedral domains*

Robert Strichartz, Cornell University: *Analysis on products of fractals*

Arpad Benyi, University of Massachusetts at Amherst: *Recent results on several classes of bilinear pseudodifferential operators*

October 2003

Marius Mitrea, University of Missouri, Columbia: *The Poisson problem in Lipschitz domains with Sobolev-Besov data*

Alexander Vladimirsky, Cornell University: *Static PDEs for time-dependent control*

Todd Kemp, Cornell University: *Hypercontractivity in non-commutative Hardy spaces*

November 2003

Alexander Bendikov, Cornell University: *New results concerning ultracontractivity*

Nelia Charalambous, Cornell University: *The spectrum of the Hodge Laplacian on differential forms, on manifolds with Ricci curvature bounded below*

January 2004

Dragomir Saric, University of Southern California: *Teichmüller theory for the universal hyperbolic solenoid*

February 2004

Ken Koenig, University of Chicago: *Regularity of the Cauchy-Riemann equations in several complex variables*

Luke Rogers, Yale University: *Extension operators for Sobolev spaces*

Dmitry Novikov, MSRI: *Oscillation of Fourier integrals with a spectral gap*

Ambar Sengupta: *Yang-Mills and Chern-Simons: mathematical problems from low-dimensional gauge theories*

March 2004

Seick Kim, University of Missouri, Columbia: *Harnack inequality for nondivergent elliptic operators on Riemannian manifolds*

Vitali Liskevich, University of Bristol: *Positive solutions of semilinear elliptic inequalities in unbounded domains*

Anna Mazzucato, Pennsylvania State University: *Enstrophy dissipation in 2D turbulence*

Mark McClure, University of North Carolina, Asheville and Cornell University: *Self-similar intersections*

April 2004

Robert Strichartz, Cornell University: *Singularities of elementary functions on the Sierpinski gasket*

Peter Lax, New York University: *Degenerate symmetric matrices*

Clifford Earle, Cornell University: *The conformal barycenter of a probability measure on the unit circle: a dynamical approach*

May 2004

Todd Kemp, Cornell University: *Hypercontractivity and free probability*

Computational and Commutative Algebra Seminar

September 2003

Alex Tchernev, SUNY at Albany: *Matroids and Taylor resolutions of multigraded modules*

Christopher Francisco, Cornell University: *The multiplicity conjecture*

October 2003

Oana Veliche, Purdue University: *Gorenstein projective dimension for complexes*

Steven Sinnott, Cornell University: *Bayesian networks and commutative algebra*

Giulio Caviglia, University of Kansas: *Characteristic-free bounds for the Castelnuovo-Mumford regularity*

November 2003

Michael Stillman, Cornell University: *Hidden variables in Bayesian networks and secant loci in projective algebraic geometry* (in two parts)

Achilleas Sinefakopoulos, Cornell University: *Points in* P^2

December 2003

Achilleas Sinefakopoulos, Cornell University: *Linear systems of plane curves*

February 2004

Christopher Francisco, Cornell University: *Inverse systems of fat points and Waring's problem* (in three parts)

Achilleas Sinefakopoulos, Cornell University: *Local cohomology* (in two parts)

April 2004

Mauricio Velasco, Cornell University: *Computational sheaf theory* (in three parts)

Discrete Geometry & Combinatorics Seminar

September 2003

Zokhrab Mustafaev, Ithaca College: *On the surface area and volume of the unit ball in normed spaces*

Robert Connelly, Cornell University: *Embedding graphs in Euclidean space*

October 2003

Maria Sloughter, Cornell University: *Rigidity questions related to the Kneser-Poulsen conjecture*

Kristin Camenga, Cornell University: *Angle sums of polytopes: a new proof of Perles' result*

Drew Armstrong, Cornell University: *A poset structure on multichains in the noncrossing partition lattice*

November 2003

Matthias Beck, MSRI: *Coefficients and roots or Ehrhart polynomials*

Edward Swartz, Cornell University: *What is a matroid?*

Robert Connelly, Cornell University: *Locally most dense circle and ellipse packings*

February 2004

Edward Swartz, Cornell University: *The h and flag h-vectors of geometric lattices*

Zokhrab Mustafaev, Ithaca College: *Convex bodies of constant width*

Igor Pak, MIT: *Unfoldings of convex polyhedra in many dimensions*

Kristin Camenga, Cornell University: *Characterizing inscribable polyhedra*

March 2004

Robert Connelly, Cornell University: *Comments on generalized Heron polynomials and Robbins' conjectures*

Carly Klivans, Cornell University: *Combinatorial properties of shifted complexes*

Tudor Zamfirescu, Dortmond, Germany: *Around the cut locus*

Federico Ardila, MSRI: *The Bergman complex of a matroid and phylogenetic trees*

April 2004

Oleg Musin, MSRI: *The kissing number in four dimensions*

Hugh Thomas, Fields Institute, Toronto: *Triangulations and non-crossing partitions in the classical types*

May 2004

Grigoriy Blekherman, University of Michigan: *Convex geometry of orbits*

Dynamical Systems Seminar

September 2003

Yakov Pesin, Pennsylvania State University: *Is chaotic behavior typical among dynamical systems?*

Dmitry Novikov, Purdue University: *Infinitesimal Hilbert 16th problem: abelian integrals and differential equations*

November 2003

Erik Bollt, Clarkson University: *A transfer operator approach to transport and control of deterministic and stochastic dynamical systems*

Kathleen Hoffman, University of Maryland: *Global analysis of the forced van der Pol equation*

December 2003

Jaume Llibre, Universitat Autònoma de Barcelona: *Darboux theory of integrability for polynomial vector fields*

January 2004

Matilde Martinez, CIMAT, Guanajuato, Mexico: *Some measures associated to Riccati foliations*

February 2004

Dmitry Novikov, MSRI: *Convex-concave hypersurfaces in real projective space*

April 2004

Allan Willms, University of Guelph: *A parameter range identification scheme for ODE models*

Omri Sarig, Pennsylvania State University: *Invariant measures for horocycle flows on abelian covers*

Kevin Lin, New York University: *Convergence of invariant densities in the small-noise limit*

May 2004

Vadims Moldavskis, Cornell University: *Polynomial vector fields and analytic foliations of* C^2

Finite Element Seminar

September 2003

Johnny Guzman, Cornell University: *Adaptive FEM for elliptic problems* (in two parts)

JaEun Ku, Cornell University: *A least-squares finite element method*

Aaron Solo, Cornell University: *Conservation of invariant domains under discretization*

October 2003

Dmitriy Leykekhman, Cornell University: *Some observations on fully discrete schemes for inhomogeneous parabolic PDEs*

Graduate Probability Seminar

All speakers are from Cornell University.

September 2003

Pavel Gyrya: *Heat kernel estimates for some noncompact domains*

José Trujillo Ferreras: *Conformal invariance of Brownian motion and applications*

Nathanaël Berestycki: *A funky problem in the theory of stochastic processes arising from a genome rearrangement model*

October 2003

Paul Jung: *Interacting particle systems* (in two parts)

Brigitta Vermesi: *Multifractal spectrum of harmonic measure of a Brownian motion path*

Evgenii Klebanov: *Stable probability measures*

November 2003

Jason Schweinsberg: *Critical exponents for percolation on the binary tree*

February 2004

Lee Gibson: *Gaussian estimates for the transition probabilities of random walks on graphs*

Nathanaël Berestycki: *An introduction to random diffusions*

Christian Benes: *Planar random walk holes*

March 2004

Parthanil Roy: *Lyapunov exponents for random logistic maps*

April 2004

José Trujillo Ferreras: *Poisson processes*

Michael Kozdron: *Simple random walk excursion measure in the plane*

Graduate Teaching Seminar

October 2003

Mean value theorem

Creating good exam questions

Approximations and polynomials in freshman calculus

Technology in the classroom

December 2003

Melanie Pivarski, Cornell University: *Day $1-\varepsilon$: What to do?*

February 2004

Christopher Hardin, Cornell University: *Using Maple TA as a tool for learning*

David Brown, Ithaca College: *Undergraduate research*

March 2004

Lee Gibson, Cornell University: *Advising undergraduates*

James Belk, Cornell University: *Big O and little o estimates and how they can be used in calculus*

Everilis Santana-Vega, Cornell University: *Presentation of research results*

April 2004

Treven Wall, Cornell University: *Service in department*

Michael Kozdron, Cornell University: *Random thoughts on life (graduate school), the universe (teaching), and everything else*

Lie Groups Seminar

September 2003

Reyer Sjamaar, Cornell University: *Imploding the double of a Lie group*

Yuri Berest, Cornell University: *Morita equivalence of Cherednik algebras*

October 2003

Victor Protsak, Cornell University: *Howe duality for enveloping algebras*

Megumi Harada, University of Toronto: *The Gel'fand-Cetlin-Molev integrable system on coadjoint orbits of U (n, H)*

Ivan Penkov, University of California at Riverside: *Generalized Harish Chandra modules*

Bertram Kostant, MIT: *Geometric quantization and the symplectic emergence of exceptional Lie groups*

November 2003

Thomas Nevins, University of Michigan: *Noncommutative deformations and Hilbert schemes of points*

Nicolas Guay, University of Chicago: *Category 0 for rational Cherednik algebras*

December 2003

Siddharta Sahi, Rutgers University: *Triple groups and double Hecke algebras*

January 2004

Jeff Adams, University of Maryland: *Nonlinear covers of real groups*

February 2004

Yuri Berest, Cornell University: *A_∞-modules and noncommutative Hilbert schemes*

Mikhail Kogan, Institute for Advanced Study: *Mirkovic-Vilonen cycles and cluster algebras*

Erez Lapid, Hebrew University: *Classification of generic unitary representations of classical groups over local fields*

Victor Protsak, Cornell University: *A concrete approach to primitive ideals in enveloping algebras*

March 2004

Stephen Bullock, NIST: *Cartan involutions of $SU(2^n)$ and entanglement dynamics*

Tara Holm, University of California at Berkeley: *Equivariant cohomology of the based loop group*

Werner Müller, University of Bonn: *Weyl's law for the cuspidal spectrum of SL_n*

April 2004

Eckhard Meinrenken, University of Toronto: *The small Cartan model*

Sam Evens, Notre Dame University: *Poisson structures on homogeneous spaces and compactifications*

Oleg Chalykh, Cornell University: *Ideals, strongly homotopy modules, and Calogero-Moser spaces*

Logic Seminar

September 2003

Michael O'Connor, Cornell University: *First order arithmetic: basics and partial truth definitions*

Yuval Gabay, Cornell University: *Inverting the double jump and initial segments of D* (in two parts)

Michael O'Connor, Cornell University: *Fragments of first order arithmetic*

John Thurber, Eastern Oregon University and Cornell University: *Some recursion theory in fragments of arithmetic* (in two parts)

Antonio Montalban, Cornell University: *The E-theory of the degrees with predicates for GH_n and GL_n $(n>0)$* (in three parts)

October 2003

John Thurber, Eastern Oregon University and Cornell University: *Basic logic in fragments of arithmetic*

Serguei Slavnov, Cornell University: *Geometric denotational semantics: a symplectic view of logic* (in three parts)

Jim Lipton, Wesleyan University: *Cut elimination and completeness of Church's intuitionistic theory of types* (in two parts)
Antonio Montalban, Cornell University: *Ramsey theorems in fragments of arithmetic*

November 2003
Antonio Montalban, Cornell University: *The Paris-Harrington theorem* (in three parts)
Christopher Hardin, Cornell University: *The Horn theory of relational Kleene algebras* (in two parts)
Yuval Gabay, Cornell University: *The Schwichtenberg-Wainer hierarchy* (in two parts)

December 2003
Piergiorgio Odifreddi, University of Turin and Cornell University: *Algebra and intuitionistic logic*

January 2004
Rahim Moosa, MIT: *The Mordell-Lang conjecture in positive characteristic*

February 2004
Richard Shore, Cornell University: *Reverse mathematics: an introduction*
Barbara Csima, Cornell University: *Degrees of prime models* (in three parts)
Richard Shore, Cornell University: *Recursive comprehension*
Michael O'Connor, Cornell University: *Arithmetic comprehension* (in three parts)
Antonio Montalban, Cornell University: *Embeddings and coding below a 1-generic*

March 2004
Greg Hjorth, UCLA: *The mad, mad world of cardinality in* $L(R)$
Christopher Hardin, Cornell University: *Weak Konig's lemma* (in two parts)
James Cheney, Cornell University: *Fraenkel-Mostowski permutation models of set theory*
James Cheney, Cornell University: *Nominal logic, names and binding*
Antonio Montalban, Cornell University: ATR_0 (in three parts)
Reed Solomon, University of Connecticut: *Reverse mathematics and equivalent definitions for well quasiorderings*

April 2004
Russell Miller, Queens College: *Spectrally universal structures*
Russell Miller, Queens College: *Infinite-time Turing machines*
Yuval Gabay, Cornell University: *Double-jump inversion for a degree rea in 0″*
Itay Ben-Yaacov, MIT: *Lovely pairs and supersimplicity*

May 2004
Lev Beklemishev, Utrecht University and Steklov Mathematical Institute: *On algebraic structures for proof theory*
Noam Greenberg, Cornell University: *The singular cardinal problem*

Number Theory and Algebraic Geometry Seminar

All speakers are from Cornell University unless otherwise indicated.

September 2003
James Belk: *Group cohomology* (in two parts)
Steven Sinnott: *Introduction to elliptic curves*
Jeffrey Mermin: *More elliptic curves*
Steven Sinnott: *Even more elliptic curves*
Spencer Hamblen: *The Brauer group*
Spencer Hamblen: *Group cohomology*
Jason Martin: *Effective Chebetarov*
Jason Martin: *Effective estimates on the density of primes in number fields*
Steven Sinnott: *Continuing elliptic curves*
Jeffrey Mermin: *More elliptic curves*

October 2003
Jason Martin: *Lecture 1 on Serre's recent paper, On a theorem of Jordan*
Henri Johnston: *Lecture 2 on Serre's recent paper, On a theorem of Jordan*
Joseph Buhler, Reed College: *Some computational density results*
Jason Martin: *Lecture 3 on Serre's recent paper, On a theorem of Jordan*
Steven Sinnott: *Continuation of lectures from Silverman's book on elliptic curves*
Jason Martin: *L-functions attached to elliptic curves*
Jason Martin: *The BSD conjecture*
Spencer Hamblen: *Recent progress toward proving the BSD* (in two parts)

November 2003
Jason Martin: *Riemann Roch on number fields* (in two parts)
Henri Johnston: *Main theorems of local class field theory*
Spencer Hamblen: *Serre's conjecture*

February 2004
Steven Sinnott: *Invariant differential of a formal group*
Ravi Ramakrishna: *Euler systems*
Steven Sinnott: *Formal groups*

March 2004
Ravi Ramakrishna: *Euler systems*
Steven Sinnott: *Elliptic curves over finite fields*
Spencer Hamblen: *Heights of elliptic curves*
Jeffrey Mermin: *L-functions on elliptic curves*
Jason Martin: *Proof of the (strong) Mordell-Weil theorem*
Jeffrey Mermin: *Continuing lectures from Silverman*

April 2004
Ravi Ramakrishna: *Euler systems* (in four parts)
Steven Sinnott: *Lectures from Silverman* (in three parts)
Jason Martin: *Some thoughts on ramification*
Jeffrey Mermin: *Lectures from Silverman* (in two parts)

Oliver Club

September 2003
Ravi Ramakrishna, Cornell University: *Galois representations and arithmetic questions*
Yakov Pesin, Pennsylvania State University: *Fubini's nightmare in smooth ergodic theory*
Almut Burchard, University of Virginia: *A dynamical Euler elastica*
Gerhard Michler, University of Essen and Cornell University: *How to calculate the order of a finite simple group*
Bodo Pareigis, University of Munich and University of California at San Diego: *Quantum groups — the functorial side*

October 2003
Joe P. Buhler, Reed College: *Symmetric functions arising in the phase retrieval problem in crystallography*
Robin Pemantle, University of Pennsylvania: *Stratified Morse theory applied to asymptotic enumeration*
Gregory Lawler, Cornell University: *The self-avoiding walk*
Bertram Kostant, MIT: *Powers of the Euler product and commutative subalgebras of a complex Lie algebra*

November 2003
Thomas Nevins, University of Michigan: *From solitons to particle systems via algebraic geometry*
George Hagedorn, Virginia Polytechnic Institute: *A review of rigorous results on molecular propagation*
Gregory Verchota, Syracuse University: *A multi-directional Neumann problem in* R^4

December 2003
Jaume Llibre, Universitat Autònoma de Barcelona: *Three hundred years of central configurations for the N-body problem: results and conjectures*

January 2004
Rahim Moosa, MIT: *The model theory of compact complex manifolds*
Inna Korchagina, Rutgers University: *The classification of the finite simple groups: aspects of the second generation proof*

February 2004
Scott Sheffield, Microsoft Research: *Flow-line geometries and Gaussian loop ensembles*
Jordan Ellenberg, Princeton University: *Counting number fields by discriminant*
Mikhail Kogan, Institute for Advanced Study: *Mirkovic-Vilonen cycles and cluster algebras*
Dan Zaffran, Cornell University: *Everything you always wanted to know about complex manifolds but were afraid to ask*
Edward Swartz, Cornell University: *Face enumeration*

March 2004
Gregory Hjorth, UCLA: *Orbit equivalence and Borel reducibility*
Lawrence Ein, University of Illinois at Chicago: *Singularities of pairs*
Werner Müller, Universität Bonn: *Spectral theory of automorphic forms*

April 2004
Indira Chatterji, Cornell University: *Group ring conjectures*
John Franks, Northwestern University: *Area preserving actions of lattices on surfaces*
Eyal Goren, McGill University: *Arithmetic applications of moduli spaces of Abelian varieties*
Irina Mitrea, Cornell University: *On the global regularity of conformal maps*

May 2004
Qing Han, Notre Dame University: *Isometric embedding of surfaces in* R^3

Olivetti Club

September 2003
Todd Kemp, Cornell University: *What holomorphic means to me*
Lee Gibson, Cornell University: *There and back again, or the ubiquitous concept of recurrence*

Melanie Pivarski, Cornell University: *The Melanie Pivarski show*

Matthew Noonan, Cornell University: *What holomorphic means to me*

October 2003

Jonathan Needleman, Cornell University: *When infinity thinks it's finite*

Radu Haiduc, Cornell University: *La chasse aux Canards or The geometric theory of singular perturbations*

Jim Pivarski, Cornell University (Physics): *Approximating everything*

Spencer Hamblen, Cornell University: *The Goldbach conjecture*

November 2003

Treven Wall, Cornell University: *What 'semigroup' means to me: some hot and fishy analysis*

Franco Saliola, Cornell University: What *'semigroup' means to me*

Dan Ciubotaru, Cornell University: *Unitary representations: some examples and motivation*

Maria Sloughter, Cornell University: *Realizability of graphs*

February 2004

Todd Kemp, Cornell University: *Duality in holomorphic spaces*

Ron Maimon, Cornell University (Physics): *Who put the hysteresis in my 2nd-order phase transition?*

Christopher Hardin, Cornell University: *Logics of knowledge*

Joshua Bowman, Cornell University: *The plants go marching n by n: garden variety affine and projective planes*

March 2004

Will Gryc, Cornell University: *Integration on manifolds*

Matthew Noonan, Cornell University: *Visualizing spin*

James Pivarski, Cornell University: *Bell's inequality: the spookiest thing about quantum mechanics*

April 2004

Aaron Solo, Cornell University: *Spatial pattern formation in chemistry and biology*

Jean Cortissoz, Cornell University: *Geometric flows*

Mia Minnes, Cornell University: *Second-order logic*

May 2004

Pizza and games with the undergraduate math club

Probability Seminar

September 2003

Eugene Dynkin, Cornell University: *Recent progress on nonlinear PDEs due to new results on superdiffusions*

Leonid Mytnik, Technion: *Regularity and irregularity of $(1+\beta)$-stable super-Brownian motion*

Gregory Lawler, Cornell University: *On the Beurling estimate for random walks*

October 2003

Robin Pemantle, University of Pennsylvania: *More rigorous results on the NK model*

Tom Pfaff, Ithaca College: *A mean field model for species abundance*

Brian Rider, Duke University: *Concentration of permanent estimators for certain large matrices*

November 2003

Richard Durrett, Cornell University: *Bipartite random graphs*

Harry Kesten, Cornell University: *A phase transition in a model for the spread of an infection*

Takashi Kumagai, Kyoto University and Cornell University: *Stability of sub-Gaussian heat kernel estimates and their applications to stochastic models*

December 2003

Michael Kozdron, Cornell University: *Excursion measure in the plane*

February 2004

Gregory Lawler, Cornell University: *Brownian loops and conformal field theory*

Scott Sheffield, Microsoft Research: *Cluster swapping and domino tilings*

Yasunari Fukai, Kyushu University: *Hitting time of a half-line by a two-dimensional random walk*

Naoki Matsuda, University of Tokyo: *Return times of random walk on generalized random graphs*

March 2004

Richard Durrett, Cornell University: *A phase transition in genome rearrangement*

José Trujillo-Ferreras, Cornell University: *New recipes for Brownian loop soup*

Hans Föllmer, Humboldt Universität, Berlin: *American options and non-linear potential theory*

April 2004

Christian Benes, Cornell University: *Counting planar random walk holes*

Jason Schweinsberg, Cornell University: *Family size distributions for multitype Yule processes*

Huyen Pham, University of Paris VI: *A large deviations control problem arising from risk management*

May 2004

Ed Perkins, University of British Columbia: *Lotka-Volterra models and super-Brownian motion*

Topology and Geometric Group Theory Seminar

September 2003

Nathan Broaddus, Cornell University: *Noncyclic covers of knot complements*

Kai-Uwe Bux, Cornell University: *Braiding chessboard complexes*

Tara Brendle, Cornell University: *Every mapping class group is generated by 3 torsion elements and by 7 involutions*

Edward Swartz, Cornell University: *Quotients of spheres by tori*

October 2003

Indira Chatterji, Cornell University: *From wall spaces to* CAT(0) *cube complexes*

James Belk, Cornell University: *Forest diagrams for Thompson's group F*

James Conant, University of Tennessee at Knoxville: *Pulling apart spheres in 4-space*

November 2003

Ruth Charney, Brandeis University: *A new look at the affine braid groups*

Olga Buse, Michigan State University: *Symplectic and complex deformations*

Kevin Wortman, Cornell University: *S-arithmetic lattices and quasi-isometric rigidity*

Inga Johnson, University of Rochester: *On the degree 2 map of a sphere*

December 2003

Lee Mosher, Rutgers University at Newark: *Teichmüller theory in outer space*

February 2004

Kai-Uwe Bux, Cornell University: *Growth in iterated monodromy groups*

Jean-Francois Lafont, SUNY at Binghamton: *Involutions of negatively curved groups with exotic boundary behavior*

Indira Chatterji, Cornell University: *Some groups acting on* CAT(0) *cube complexes*

Kevin Wortman, Cornell University: *Large-scale geometry of discrete subgroups of semisimple Lie groups*

March 2004

Peter Kahn, Cornell University: *Group extensions and symplectic torus bundles*

Ross Geoghegan, Binghamton University: *The* FP_n *conjecture for metabelian groups*

Dan Margalit, University of Utah: *Braid groups are almost co-Hopfian*

Murray Elder, University of St. Andrews (Scotland): *Regular, context-free and counter languages of geodesics*

April 2004

Saul Schleimer, University of Illinois at Chicago: *Heegaard splittings and Haken's program*

Will Kazez, University of Georgia: *Contact structures and convex decompositions*

Mustafa Korkmaz, Middle East Technical University (Turkey): *Homomorphisms from mapping class groups*

Sema Salur, Northwestern University: *Deformations of calibrated submanifolds*

G. Christopher Hruska, University of Chicago: *Lattices in trees and 2-complexes*

May 2004

Graham Niblo, University of Southampton (England): *Hilbert space compression and exactness for groups acting on* CAT(0) *cube complexes*

Christophe Pittet, Université de Marseille: *Is the Dehn function of* SL(4, *Z*) *quadratic?*

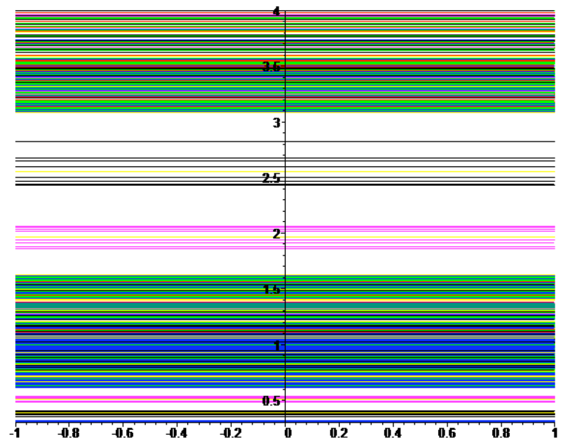
Research Experiences for Undergraduates Program

Every summer since 1994, the Cornell Mathematics Department has offered a Research Experiences for Undergraduates (REU) Program, sponsored by the National Science Foundation. This program brings talented undergraduates from Cornell and colleges across the country to work on research projects directed by Cornell faculty. By pooling resources with other programs, we were able to support a total of 16 students during summer 2003. For the first time in the history of our program, women students outnumbered the men.

Summer 2003 projects were Analysis on Fractals, directed by Robert Strichartz, Complex Dynamics and Number Theory, directed by Rodrigo Perez, and Probability Problems from Genetics, directed by Richard Durrett. Cornell graduate students Pavel Gyrya, James Worthington, and Deena Schmidt assisted with the projects. In addition to their research work, the students attend a Smorgasbord Seminar where Cornell faculty give talks about different areas of mathematics. The students gave presentations on their work to each other in a weekly Jam Session and also to the whole Cornell Mathematics community at the final Undergraduate Research Forum. Several papers based on the research are in preparation.

Analysis on Fractals

Students working on Analysis on Fractals followed a tradition started in 1996: A substantial portion of research in this area has come out of our REU Program. The students, Nitsan Ben-Gal (Michigan), Brian Bockelman (State University of West Georgia), Abby Shaw-Kraus (UCLA), and Clint Young (Binghamton), were building on the work of previous "generations" of REU students and also striking out in new directions. Understanding the possible point singularities of functions of polynomial and exponential types on the Sierpinski gasket (SG) was one of this summer's accomplishments. This may seem strange, because in the Euclidean setting these types of functions do not have singularities. But the fractal world is different. This work involved both theoretical and experimental mathematics, using computer programs to explore possibilities and suggest conjectures. Another area that was explored for the first time was the analog of partial differential equations on SG^2, the product of SG with itself. Here we developed software to numerically approximate the solutions of these equations using the finite element method, building on earlier software for solutions of differential equations on a single copy of SG. We also discovered a new type of p.d.e. on SG^2 that has no analog in the non-fractal world, exploiting the fractal-like structure of gaps in the spectrum of the Laplacian on SG.



Ratios of eigenvalues of the Laplacian on the Sierpinski gasket, computed by Brian Bockelman. (Note the gaps.)

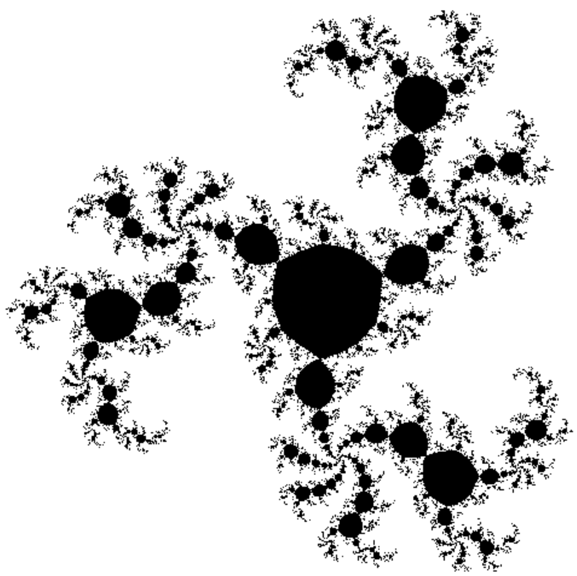
Complex Dynamics and Number Theory

Students on the Complex Dynamics and Number Theory project studied fractal Julia sets with a number theory twist: There is a string of integers associated to the Julia set of any complex polynomial with one critical point. This numerical invariant known as an "itinerary" describes the structure of the Julia set, and the question arises of classifying Julia sets according to their itineraries. This leads to counting identities that can be proved with algebraic methods, but which are likely to remain undiscovered if the dynamical motivation is not present.

Yelena Yassinik (MIT) and Matthew Holden (Pomona College) worked on the description of polynomials with a critical orbit that is finite but not periodic. They obtained a general formula to count polynomials whose critical orbit has preperiod m and period n, and went on to provide a thorough classification.

Gwyneth Whieldon (St. Mary's College, MD) and Andrew Bridy (Cornell) looked at the role played by renormalization in the classification of polynomials with periodic critical orbit. The phenomenon of renormalization is invisible to the algebraic proof of the identity for this case. Andy found some formulas that are helping him study the asymptotic growth of the number of renormalizable polynomials of period n. This additional work is almost finished.

Two other Cornell students, Vorrapan Chandee and Grace Qiu, studied the case of periodic polynomials with real coefficients. This restriction is hard to encode in terms of the itineraries, so Vorrapan and Grace had to incorporate techniques of real dynamics. They rediscovered a formula for the number of real polynomials with critical orbit of period *n* and gave a new proof. They also found a characterization of itineraries that correspond to real polynomials and are working on determining the number of real polynomials with a given itinerary.



This is the Julia set of a cubic polynomial. Notice that there are five branches at each spiral point. The purpose of this REU project was to catalog Julia sets with postcritically finite orbit.

Probability Problems from Genetics

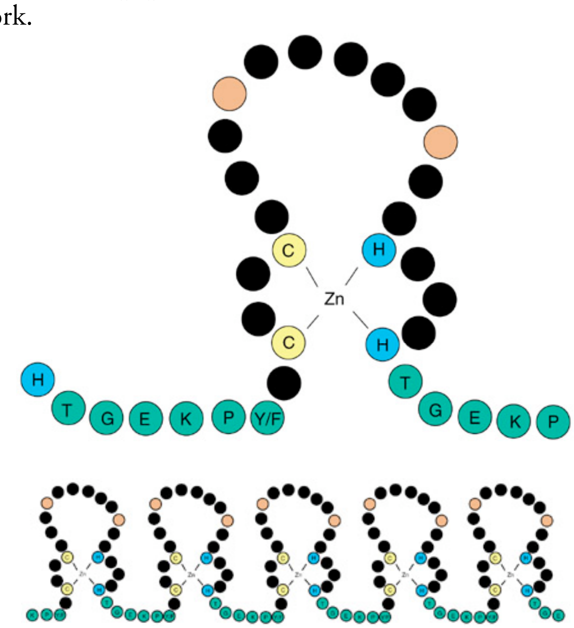
Many students in the Probability Problems from Genetics project investigated gene duplication. Elizabeth Rach (Cornell) studied probability models of the growth of gene families in order to find explanations of why the sizes of gene families follow a power law.

Rachel Ward (University of Texas, Austin) examined predictions of the subfunctionalization model, which postulates that gene copies are preserved because they evolve to perform complementary functions. One of her surprising findings was that a model that should move around in six-dimensional space spent most of its time near a particular curve.

Amanda Stephens (Rose Hulman) and Mandy Pfeister (University of Colorado, Boulder) studied duplication patterns in the *q* arm of human chromosome 19 and the homologous part of mouse chromosome 7. They discovered many examples of adjacent gene duplicates but found that these duplicates preferentially occurred in a few families, suggesting that these mutations were not random changes but beneficial, e.g., to increase the number of toxins that can be identified and eliminated.

Jon Winkler (Arizona State University) studied DNA sequences from a statistician's perspective—assuming they are a sequence of letters from a four-letter alphabet output by a black box. Statistical irregularities of the chromosomes he examined led him to rediscover some known features (e.g., the high mutability of CG pairs) but revealed some other striking patterns that have no known explanation.

Oxford graphs, which indicate the evolutionary relationship between chromosomes in two species, are bipartite graphs and each vertex has degree at least 1. Jonah Blasiak (Princeton) investigated properties of a random pick from the set of Oxford graphs with *m* left vertices, *n* right vertices, and *k* edges. In particular, he found conditions on *m*, *n*, and *k* for the existence of a giant component or for the graph to be fully connected with high probability. These results, which we expect to have published in a probability journal, are one of the four or five papers that will result from the summer's work.



Structure of the zinc finger produced by the binding of two amino acids to a zinc ion. Letters indicate conserved amino acids.

For the summer of 2004, the REU Program will continue with the following projects: Analysis on Fractals (Robert Strichartz), Dynamical Systems with Multiple Time Scales (John Guckenheimer and Warren Weckesser), and Differential Equations Arising in Geometry (Alexander Meadows).

Community Outreach

Math Explorer's Club

The Math Explorer's Club has existed since the beginning of our VIGRE grant in the fall of 2000. In its first 2.5 years it was a 2.5-hour Saturday activity at Cornell, but gradually it lost out to the busy schedules of high school students. In the fall of 2003, thanks to some support from the provost, it came back to life as one of the many after school clubs at Ithaca High School that meet for 45 minutes at the end of the school day. Karen Seifert, an IHS teacher, is the club sponsor. She does local advertising and gives us feedback on our activities. The weekly event takes place in Dave Bock's classroom, even though I am sure that the noise drives him crazy while he is trying to do his work or tutor students.

Rick Durrett, with the assistance of CAM graduate student Sharad Goel, led the first set of activities, which involved learning probability by playing games. The first meeting advertised black jack and free pizza and brought an overflow crowd of 39 students to learn Thorpe's basic strategy, which reduces the house advantage to zero. Other topics in applied probability that have been covered include craps, yahtzee, backgammon (especially the use of the doubling cube), poker (lowball and Texas Hold'em), and the nonrandom game *Set*.

After Christmas break, Kristin Camenga got things started by introducing the students to concepts in graph theory by playing a number of games: Sprouts, Slither, Chomp, Nim, Ramsey Graph games, and the puzzle Instant Insanity. The students were very adept at finding good solutions. While they were having fun, they learned a lot of graph theory and even learned a little about proofs in the analysis of optimal strategies.

Graduate student Treven Wall and VIGRE postdoc (and IHS alumnus) Lawren Smithline led the second spring module on Secret Codes. The first lesson began with simple substitution ciphers like the Crytoquip in the paper. The level of complexity was then increased to the polyalphabetic Vignere cipher, transposition ciphers, and the enigma machine that was used in World War II. Finally, after a quick course in modular arithmetic, the students were introduced to Diffie Hellman and RSA "Public key" systems that take advantage of the fact that it is difficult to factor the product of two large primes.

The third module on Fun with Geometry began in early May and was led by Sunny Fawcett. The first week the students ate toruses (donuts) and played chess and Tic Tac Toe on toruses and Klein bottles, as many of us saw in Jeff Weeks' Kieval Lecture (see p. 29). The second week, students built platonic solids from polydrons: plastic polygons with 3–6 sides. Dave Bock was kind enough to point out as he was leaving that day that while it was a beautiful spring day outside there were a dozen students who were hard at work building models. Thirty-one students have attended two or more meetings since January. When ski club was cancelled due to a –26-degree wind chill there were over 20 students, with a steady attendance of 12–15.

Those who are curious about what we did this year can visit the MEC web site

www.math.cornell.edu/~durrett/mec/mec.html

to learn some of the math behind the activities. Carla Martin created the web site with the support of our VIGRE grant. The idea behind this site is to create an archive of tested materials that can be used by students and teachers throughout the country to facilitate the development of similar programs in other communities. If the last sentence sounds like it is from a grant proposal, you are right. During the spring and summer of 2003, Rick Durrett and Maria Terrell hatched a plan for expanding our outreach activities on a national scale and developing materials on applications of math for the high school curriculum.

Since the ultimate aim of our plan is to interest more high school and middle school students in mathematics as a career, a proposal, with co-PI's Ken Brown and Karen Vogtmann, was submitted to the Mentoring Critical Transition Points (MCTP) subprogram of NSF's recently revised suite of infrastructure programs. In addition to Ken and Karen, the proposal and the formulation of the new Math Explorer's Club received valuable input from David Henderson, Avery Solomon, Daina Taimina, Charlie Troutman of the ScienCenter, Dave Bock and Tom Mariano at Ithaca High school.

Unfortunately, our proposal was not one of the four winners from the forty submitted. NSF program officers and some of the panel members were enthusiastic but others did not understand or did not believe that we could export our efforts to the country as a whole. We are now preparing a proposal that takes the reviewers' comments into account. When the first proposal was written, the club was just an idea. With a year of experience and material on the web site, we are optimistic that we will finish in the money on our next trial.

Ithaca High School Senior Seminar

Funded by the department's VIGRE grant, the Senior Mathematics Seminar is an advanced mathematics option that covers topics not normally found in high school or even in most mainstream undergraduate courses. During the 2003–2004 academic year, Cornell graduate students Sharad Goel, James Belk and Jay Henniger organized the seminar, which met for three periods a week during school hours at the high school. Fifteen IHS students attended.

The organizers each led a module. Sharad Goel's game theory module focused on developing some basic theoretical techniques in game theory and applying those tools to analyze a number of concrete games. After discussing solution concepts such as pure and mixed Nash equilibria and dominated actions, the class studied a number of real life situations that could be modeled as games, including auctions and elections.

Jay Henniger's module focused on various problems in combinatorics with an emphasis on developing student ability in forming logical arguments and writing proofs. Participants studied perfect covers of chessboards, magic squares and magic cubes, binomial coefficients, chains and clutters. Students often worked together in small groups and frequently considered multiple methods for solving a given problem.

Jim Belk's module focused on the topology of graphs and surfaces. Students worked in groups to explore such concepts as isomorphism of graphs, embeddings of graphs on surfaces, homeomorphisms, cell divisions of surfaces and Euler characteristic. This culminated in a discussion of Conway's ZIP proof for the classification of surfaces.

With help from the organizers, students concluded the year by researching and presenting topics of their choice. Some of the projects included discussing game theory and the law, analyzing the game of Set, investigating planetary motion, developing cryptographic methods, and studying fractals. In several instances, the students proved new results.

Cornell/Schools Mathematics Resource Program

Initiated in 1985 by Cornell's Committee on Education and the Community, the Cornell/Schools Mathematics Resource Program was developed and facilitated by David Henderson and Avery Solomon and has received continued funding and support from Cornell. The CSMRP is aimed at improving the state of mathematics teaching and learning by providing in-service mathematics courses and workshops for teachers, researching and developing materials for the classroom that follow a broader approach to mathematics, and initiating and supporting cooperative efforts between Cornell University and local schools.

The Saturday workshops during 2003-2004 included presentations by Maria Terrell on her Good Questions project; Rick Durrett and Sharad Goel on the Math Explorers Club; and Steve Weissberg of Ithaca High School on his experiences teaching in South Africa.

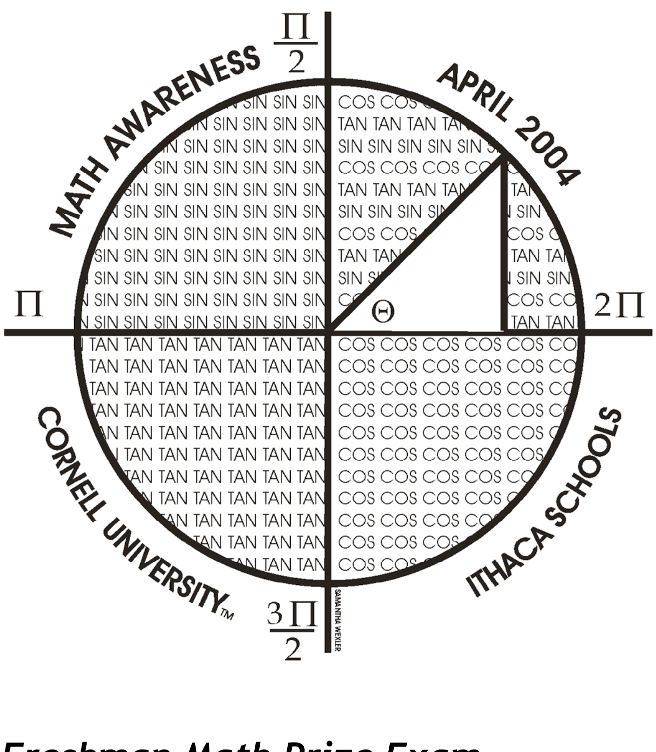
The program worked closely with the Ithaca High School Mathematics Department to implement their pilot program teaching a new, NSF-funded curriculum. Almost every mathematics teacher at the high school has been involved, along with all the Cornell students who will be student teaching next year. Avery Solomon also presented two sessions at the Corning Community College math day to about 100 high school students, and taught workshops on Geometer's Sketchpad software.

Michael D. Morley Ithaca High School Prize in Mathematics

Lawren Smithline presented the Michael D. Morley Ithaca High School Prize in Mathematics to Thomas Brennan, a senior at Ithaca High School who demonstrated substantial interest and significant native ability in mathematics. Thomas was one of six finalists chosen by faculty at Ithaca High School. A panel made up of Michael Morley, Lawren Smithline and Kristin Camenga interviewed the four finalists, posing thought-provoking mathematical problems designed to test for cleverness and the ability to "think like a mathematician." The prize, formerly known as the Ithaca High School Senior Prize, is funded largely by faculty contributions. Lawren Smithline won the prize as an Ithaca High School student one of the first years it was given.

Mathematics Awareness Week At Area Schools

The American Mathematical Society encourages universities to support the idea of a math awareness week in April at area schools, and Cornell has participated in this practice since its inception. Robert Strichartz, Ravi Ramakrishna, Daina Taimina, and Avery Solomon gave talks in local math classrooms. Cornell sponsored its annual T-shirt design contest, won by Samantha Wexler, a student at Ithaca High School. The Departments of Mathematics at Cornell University and Ithaca High School underwrote the cost of producing 84 shirts that were distributed to staff and students at Cornell and area schools. At Ithaca High, students won the shirts as prizes for solving a math problem of the day, or a more extensive weeklong challenge.



Freshman Math Prize Exam

The fifth annual Freshman Math Prize Exam was held on April 7, 2004, organized by Professors Kai-Uwe Bux and Martin Dindos. This is a challenging prize exam open to all freshmen at Cornell. Although the problems do not require any mathematics beyond elementary calculus, they do require intuition, ingenuity and persistence. Here is an example: "A box contains 7 white balls and 8 black balls. If 3 balls are drawn from the box at random, what is the probability of drawing 2 white balls and 1 black ball?" Five students were declared winners this year. Zachary Scherr won first prize. Thiti Taychatanapat and Evan Marshak tied for second prize. Ameya Agaskar and Joshua Wiener tied for third prize.

Mathematics Awareness Month Public Lecture

On April 14th, Prof. Steve Strogatz of the Department of Theoretical & Applied Mechanics gave the 2004 Mathematics Awareness Month Lecture to a standing room only crowd. The lecture, which was based on his book *Sync,* explored the tendency to synchronize, one of the most mysterious and pervasive drives in all of nature. His first film clip showed thousands of fireflies flashing in silent, hypnotic unison along the tidal rivers of Malaysia. He explored a number of other examples and explained some of the mathematics behind the models. The final example was the Millennium Bridge in London, which opened early in 2000 but had to be almost immediately shut down because people walking on the bridge created oscillations that in turn caused people to lurch from foot to foot to maintain their balance, which made the oscillations worse. Steve's stories were entertaining and held the audience's attention but, as Ravi Ramakrishna said the next day, "There was a lot of math in that talk for a public lecture." Ravi is right in that it was not really a talk to bring people in from Ithaca but it did bring people from a wide variety of departments on campus to Malott Hall.

Expanding Your Horizons

Created in 1976, Expanding Your Horizons in Science and Mathematics is a national program aimed at encouraging middle-school girls' interest in math and science and motivating them to continue taking math and science courses throughout high school. Organized and run by women in mathematics and science, it is held in over 100 locations nationwide. The Math/Science Network — a non-profit membership organization of educators, scientists, mathematicians, parents, community leaders, and government and corporate representatives — licenses and coordinates this network of EYH conferences (www.expandingyourhorizons.org). M/SN's mission is to promote the continuing advancement in mathematics and science education of all people, with a particular emphasis on the needs of women and girls. It initiates local EYH sites and provides them with technical assistance and conference and planning materials, as well as support services such as coordinated publicity and public relations posters and buttons. The Network also provides a "networking" link between sites.

On April 24, 2004, members of the Cornell Mathematics Department participated in a day of hands-on workshops in mathematics for 7th, 8th, and 9th grade girls. The Mathematics Department featured a workshop on probability, run by several students in the department.

In the workshop *Fortune Telling for the 21st Century*, graduate students Evgueni Klebanov, Mia Minnes, Jonathan Needleman, Melanie Pivarski, Maria Sloughter, and Treven Wall worked with a group of girls doing probability puzzles. At the beginning of the workshop we asked the girls, “What is mathematics?” Answers ranged from “numbers,” “shapes,” and “complicated” to “thinking,” “learning,” and “laughing.” We also consulted an oracle, which told us, “You will change your mind about this.” We then proceeded to try different puzzles. For each puzzle, the girls predicted what the most likely outcome would be, collected data on what happened during their experiment, and then compared the results to their predictions. After experimenting for a while, the girls developed an intuition for what was happening. They were able to come up with reasons why some outcomes were more likely than others. At the end of the workshop, we asked some of the more apprehensive girls whether they changed their minds about math. They had. “Math can be fun.”

K-12 Education and Outreach Coordinator

The Mathematics Department has decided to significantly increase its outreach efforts to local schools and the K-12 education community. The department has hired David Bock through a national search for an Outreach Coordinator. David was a teacher Ithaca High School for 32 years, where he developed an outstanding reputation as an enthusiastic and inspiring teacher and mentor to other teachers. He is the author of successful statistics textbooks for high school students. During the academic year 2000–2001, he spent a sabbatical year in our department, teaching courses in statistics. He will now have responsibility for coordinating outreach efforts of the Mathematics Department.

Dave will teach two undergraduate mathematics courses each semester. One of these will be a lecture of MATH 171 (*Statistics with Applications in the Real World*) and the other will be a course for prospective mathematics teachers. He will also explore ways to expand and improve Cornell’s mathematics teacher preparation program, including developing cooperative arrangements with other institutions, developing initiatives to recruit mathematics majors into teaching careers, and he will supervise up to four student teachers per year.

Mathematics Library

The Mathematics Library continues to have a high level of use that often finds most of the library computers in use and many seats full. While scholarly journals are moving online, books remain in the paper world and the total use of the print collection continues to grow. Paintings and items of interest are on display in the library. Most notable is a collection of oil paintings of early faculty of the Mathematics Department, including a large portrait of James Edward Oliver, who started the department colloquium series in 1891.

The Mathematics Library collection at Cornell is one of the finest in the nation and supports research and instruction in mathematics and statistics for the Cornell community. The research collection consists of works on mathematics, statistics, applied mathematics, mathematics education, and the history of mathematics. For undergraduates with an interest in mathematics, the library is a wonderful resource for materials to support instructional and career needs as well as expository and recreational reading. The library collection has great historic depth and breadth and includes materials from around the world in many languages.

An increasing portion of the journals in the library collection is now available both on paper in the library and online to all Cornell users. A number of journals are now available only online where the University Library has negotiated site license contracts that make the online-only option financially favorable and provide archival reliability. Online journals are important, but they are not less expensive than the printed resources they will eventually replace. A crisis in scholarly communications is looming, largely because commercial publishers are pushing up the prices of their journals at a rate that is not sustainable. You can read more on this at: www.library.cornell.edu/scholarlycomm/issues.html.

The university-appropriated budget for the library continues to grow but not as fast as the cost of journals from a few large commercial publishers. In stark contrast, independent, society, university press, and not-for-profit journals are not increasing prices at an unsustainable rate. Relatively few titles from a few large commercial publishers consume the majority of the library's appropriated budget.

Gifts to the library endowment have made endowment income the primary source of funds for the purchase of books. Thanks to generous gifts from our donors, endowment income grew from 1.5% of our budget in 1990 to 20% in fiscal year 2002–2003. Unfortunately, the downturn in the economy has reduced endowment payout for two years in a row. Ongoing gifts to the principle of the endowment have offset this somewhat. Also, two book sales of duplicate gift books resulted in almost $3,000, which was added to the endowment principle. Gifts are the difference between an excellent library and a mediocre one. Our endowments purchase essentially all the monographs we order individually.

The Mathematics Library encourages and welcomes all patrons in the Cornell community to use its resources. Reciprocal interlibrary loan agreements with other institutions make Cornell's resources available throughout the world and open the world to Cornell researchers. The need for quantification, analysis, and more mathematical sophistication in the social, biological, and engineering sciences attracts a spectrum of patrons from across the campus and generates frequent use of the collection. A full range of reference, circulation, printing, and photocopy services are available in person and via phone, e-mail, or the World Wide Web.

The library staff consists of Steven Rockey, director of the library, Natalie Sheridan, branch manager, and approximately a dozen part-time undergraduate student employees. The veteran professional staff and competent student employees are always ready to serve the public, and they welcome feedback. A primary goal is to make the library experience for the staff and patrons interesting, productive, and enriching in a small and personal environment.

The Mathematics Library's World Wide Web home page has been redesigned and relocated to: www.library.cornell.edu/math/. It includes information about the Mathematics Library's services and hours of operation, as well as pointers to bibliographic indexes such as MathSciNet and our locally created bibliography of "collected works" of mathematicians, links to other mathematical science resources, etc. Library personnel are always adding new and relevant links to this home page. Visit our library, our home page, or contact us electronically or by telephone to find out how the Mathematics Library can serve you.

Special Projects

Cornell is involved in a number of digitization projects relating to mathematics (www.library.cornell.edu/digital/math-projects.html). An overview of worldwide mathematics digitization efforts is available at: www.library.cornell.edu/math/digitalization.php. Here are some project highlights.

Project Euclid (projecteuclid.org)

Project Euclid is Cornell University Library's electronic publishing initiative in mathematics that is now fully functional and has grown to 34 titles. Project Euclid is a user-centered initiative to create an environment for the effective and affordable distribution of serial literature in mathematics and statistics. The journal publishers join forces and participate in an online presence with advanced functionality, without sacrificing their intellectual or economic independence or commitment to low subscription prices. Full-text searching, reference linking, interoperability through the Open Archives Initiative, and long-term retention of data are all-important components of the project.

Cornell University Math Collection (library5.library.cornell.edu/math.html)

This is a collection of 576 digitized books that were scanned from originals held by the Mathematics Library. The titles can be viewed electronically. The Mathematics Library also does a brisk business selling bound paper facsimiles to libraries and individuals. The Math Books collection is mostly composed of old books that are out of copyright but still mathematically relevant.

DML — Digital Mathematics Library (www.ceic.math.ca/WDML/index.shtml)

The successful Cornell-coordinated planning of the DML has resulted in the ongoing World DML project coordinated under the auspices of the International Mathematical Union.

EMANI — Electronic Mathematics Archives Initiative (www.emani.org)

This is a collaborative effort between the German scientific publisher Springer and the libraries at Cornell, Göttingen, Tsinghua (Beijing), and Orsay (Paris). EMANI will focus on the archiving of digital mathematics literature, and also addresses repository and dissemination issues. Springer wishes to establish its reputation as a leader in digital archiving in a public-spirited fashion and hopes to benefit from the good will this can generate. Springer also hopes that a systematic and collaborative approach to digital archiving will speed their transition to electronic-only publishing. EMANI is expected to be an important component in the broader Digital Mathematics Library initiative if Springer can in fact offer a model for other publishers of an open and collaborative approach to issues of archiving and access provision.

The Faculty and their Research Areas

Dan M. Barbasch, Professor; Ph.D. (1976) University of Illinois; Representation theory of reductive Lie groups

Yuri Berest, Assistant Professor; Ph.D. (1997) Université de Montreal (Canada); Mathematical physics and algebraic geometry

Louis Billera, Professor; Ph.D. (1968) City University of New York; Geometric and algebraic combinatorics

Kenneth S. Brown, Professor and Chair; Ph.D. (1971) Massachusetts Institute of Technology; Algebra, topology, group theory

Stephen U. Chase, Professor; Ph.D. (1960) University of Chicago; Non-commutative algebra, homological algebra, Hopf algebras, group theory

Robert Connelly, Professor; Ph.D. (1969) University of Michigan; Discrete geometry, computational geometry and the rigidity of discrete structures

R. Keith Dennis, Professor; Ph.D. (1970) Rice University; Commutative and non-commutative algebra, algebraic K-theory, group theory, mathematical bibliography

Richard Durrett, Professor; Ph.D. (1976) Stanford University; Problems in probability theory that arise from ecology and genetics

Eugene B. Dynkin, A. R. Bullis Chair and Professor; Ph.D. (1948), Dr. of Science (1951) Moscow University; Probability theory, Lie groups

Clifford J. Earle, Professor; Ph.D. (1962) Harvard University; Complex variables, Teichmüller spaces

José F. Escobar, Professor; Ph.D. (1986) University of California at Berkeley; Partial differential equations; differential geometry

Leonard Gross, Professor; Ph.D. (1958) University of Chicago; Functional analysis, constructive quantum field theory

John M. Guckenheimer, Professor; Ph.D. (1970) University of California at Berkeley; Dynamical systems

Allen Hatcher, Professor; Ph.D. (1971) Stanford University; Geometric topology

Timothy Healey, Professor and Chair of Theoretical and Applied Mechanics; Ph.D. (1985) University of Illinois; Nonlinear elasticity, nonlinear analysis, partial differential equations

David W. Henderson, Professor; Ph.D. (1964) University of Wisconsin; Educational mathematics, geometry

John H. Hubbard, Professor; Doctorat d'Etat (1973) Université de Paris Sud; Analysis, differential equations, differential geometry

J.T. Gene Hwang, Professor; Ph.D. (1979) Purdue University; Statistics, confidence set theory

Yulij Ilyashenko, Professor; Ph.D. (1969) Moscow State University; Dynamical systems

Peter J. Kahn, Professor; Ph.D. (1964) Princeton University; Symplectic topology/geometry

Dexter Kozen, Professor of Computer Science; Ph.D. (1977) Cornell University; Computational theory, computational algebra and logic, logics and semantics of programming languages

Gregory Lawler, Professor; Ph.D. (1979) Princeton University; Probability, statistical physics

Camil Muscalu, Assistant Professor; Ph.D. (2000) Brown University; Harmonic analysis and partial differential equations

Anil Nerode, Goldwin Smith Professor; Ph.D. (1956) University of Chicago; Mathematical logic, recursive functions, computer science, mathematics of AI, control engineering

Michael Nussbaum, Professor; Ph.D. (1979) Academy of Sciences Berlin (Germany); Mathematical statistics

Irena Peeva, Assistant Professor; Ph.D. (1995) Brandeis University; Commutative algebra and algebraic geometry

Philip Protter, Professor of Operations Research and Industrial Engineering; Ph.D. (1975) University of California at San Diego; Probability theory, stochastic calculus, stochastic differential equations, stochastic numerical methods, mathematical finance theory, credit risk

Ravi Ramakrishna, Associate Professor; Ph.D. (1992) Princeton University; Algebraic number theory

Richard Rand, Professor of Theoretical and Applied Mechanics; Sc.D. (1967) Columbia University; Applied mathematics and differential equations

James Renegar, Professor of Operations Research and Industrial Engineering; Ph.D. (1983) University of California at Berkeley; Optimization algorithms

Laurent Saloff-Coste, Professor; Ph.D. (1983) and Doctorat d'Etat (1989) Université Paris VI; Analysis, potential theory, stochastic processes

Alfred H. Schatz, Professor; Ph.D. (1964) New York University; Numerical solutions of partial differential equations

Shankar Sen, Professor; Ph.D. (1967) Harvard University; Algebraic number theory

Richard A. Shore, Professor; Ph.D. (1972) Massachusetts Institute of Technology; Mathematical logic, recursion theory, set theory

Reyer Sjamaar, Associate Professor; Ph.D. (1990) Rijksuniversiteit te Utrecht (RUU), the Netherlands; Symplectic geometry

John Smillie, Professor; Ph.D. (1977) University of Chicago; Dynamical systems

Birgit E. Speh, Professor; Ph.D. (1977) Massachusetts Institute of Technology; Lie groups, automorphic forms, representation theory

Michael E. Stillman, Professor; Ph.D. (1983) Harvard University; Algebraic geometry, computational algebra

Robert S. Strichartz, Professor; Ph.D. (1966) Princeton University; Harmonic analysis, partial differential equations, analysis on fractals

Edward Swartz, Assistant Professor; Ph.D. (1999) University of Maryland at College Park; Combinatorics and discrete geometry

William Thurston, Professor; Ph.D. (1972) University of California at Berkeley; Topology

Alexander Vladimirsky, Assistant Professor; Ph.D. (2001) University of California at Berkeley; Numerical methods, dynamical systems, nonlinear PDEs, control theory

Karen Vogtmann, Professor; Ph.D. (1977) University of California at Berkeley; Topology, geometric group theory

Lars B. Wahlbin, Professor; Ph.D. (1971) University of Göteborg, Sweden; Numerical solutions of partial differential equations

James E. West, Professor; Ph.D. (1967) Louisiana State University; Geometric topology, infinite-dimensional topology

Faculty Profiles

Allen Back

Senior Lecturer of Mathematics and Network Administrator

My original training was primarily in differential geometry and secondarily in topology. The most interesting portion of my earlier work was related to the role of compact Lie group actions in differential geometry, especially curvature realizability questions. I've been impressed by a variety of recent progress in this area (e.g. Einstein metrics and positive Ricci curvature on many cohomogeniety one manifolds) and have been working on what further directions may now be fruitful.

Besides equivariant differential geometry, other areas of past work and interest include transformation groups, homotopy theory, dynamical systems, some parts of mathematical physics, geometric modeling and robotics. My work as director of the Instructional Computing Lab meshed with a long-standing interest in the use of computers for mathematical enrichment.

Selected Publications

Rational Pontryagin classes and killing forms, J. Differential Geom. **16** no. 2 (1981), 191–193.

Pontryagin forms on homogeneous spaces, Comment. Math. Helv. **57** no. 3 (1982), 349–355.

Equivariant geometry and Kervaire spheres (with Wu Yi Hsiang), Trans. AMS **304** no. 1 (1987), 207–227.

dstool: Computer assisted exploration of dynamical systems (with J. Guckenheimer, M. Myers, F.J. Wicklin and P. Worfolk), Notices AMS **39** (1992), 303–309.

Mathematics and tensegrity (with R. Connelly), American Scientist March-April (1998), 142–151.

Dan Barbasch

Professor of Mathematics

My research is in the field of representation theory of reductive Lie groups. I am particularly interested in the classification of the unitary dual for groups over local fields, and its relation to the orbit structure of the Lie algebra. Furthermore I am interested in the relation of these representations to problems arising from number theory, more precisely automorphic forms.

Selected Publications

Unitary spherical spectrum for split classical p-adic groups, Acta Applicandae Mathematicae **44** (1996).

Local character expansions (with A. Moy), Ann. Sci. de L'Ecole Norm. Sup. (1997).

The associated variety of an induced representation (with M. Bozicevic), Proc. AMS (1998).

The spherical dual for p-adic groups (with A. Moy), Proc. of Conf. in Cordoba, Argentina.

The associated variety of unipotent representations, preprint.

Yuri Berest

Assistant Professor of Mathematics

My research interests include mathematical physics, algebraic geometry and noncommutative algebra. I am particularly interested in various interactions between these fields. Some of my recent work is related to the study of algebras of differential operators on singular algebraic varieties and representation theory of Cherednik algebras.

Selected Publications

Automorphisms and ideals of the Weyl algebra (with G. Wilson), Math. Ann. **318** no. 1 (2000), 127–147.

Ideal classes of the Weyl algebra and noncommutative projective geometry (with G. Wilson and M. van den Bergh), Internat. Math. Res. Notices **26** (2002), 1347–1396.

Finite-dimensional representations of rational Cherednik algebras (with P. Etingof and V. Ginzburg), Internat. Math. Res. Notices **19** (2003), 1053–1088.

Cherednik algebras and differential operators on quasi-invariants (with P. Etingof and V. Ginzburg), Duke Math. J. **118** no. 2 (2003), 279–337.

Morita equivalence of Cherednik algebras (with P. Etingof and V. Ginzburg), J. Reine Angew. Math. **568** (2004), 81–99.

Louis J. Billera

Professor of Mathematics

For some time, my research has centered on combinatorial properties of convex polytopes and their relations to algebraic and geometric questions. Some questions are related to the facial structure of polytopes, for example, enumeration of faces or identification of their lattice structure. Others have to do with subdivisions of polytopes, how they might depend on the geometry (as opposed to the combinatorics) of the underlying set, or how the algebraic properties of objects related to a given subdivision, for example the algebra of smooth piecewise polynomial functions (splines) defined on it, might depend on both combinatorial and geometric factors.

A common theme in much of this has been the construction of polytopes to given specifications: for example the construction with Carl Lee of polytopes satisfying the conditions of McMullen's *g*-conjecture, showing these conditions to be sufficient to describe the enumeration of faces of all simplicial convex polytopes; or the construction with Bernd Sturmfels of fiber polytopes, showing that certain sets of polyhedral subdivisions of polytopes themselves had the structure of convex polytopes; or the construction with A. Sarangarajan of faces of the traveling salesman polytope, showing this polytope to have every possible 0-1 polytope as a low-dimensional face. In addition, we have used some of these techniques to study interesting problems arising in biology involving the structure of phylogenetic trees.

More recently, I have been studying algebraic structures underlying the enumeration of faces and flags in polytopes. This has led to the study of connections with the theory quasisymmetric and symmetric functions.

Selected Publications

Generalized Dehn-Sommerville relations for polytopes, spheres, and Eulerian partially ordered sets (with M. M. Bayer), Inv. Math. **79** (1985), 143–157.

Homology of smooth splines: generic triangulations and a conjecture of Strang, Trans. Amer. Math. Soc. **310** (1988), 325–340.

Fiber polytopes (with B. Sturmfels), Annals of Math. **135** (1992), 527–549.

Geometry of the space of phylogenetic trees (with S. Holmes and K. Vogtmann), Advances in Applied Mathematics **27** (2001), 733–767.

Peak quasisymmetric functions and Eulerian enumeration (with S. K. Hsiao and S. van Willigenburg), Advances in Mathematics **176** (2003), 248–276.

David Bock

Senior Lecturer of Mathematics and K-12 Education and Outreach Coordinator

I am generally interested in the teaching and learning of mathematics. I coordinate Mathematics Department outreach efforts that bring department members together with K–12 students for enrichment activities and with teachers for professional development opportunities. I also lead workshops for current and pre-service teachers. Currently I am active in the development of pedagogical initiatives for undergraduate statistics and have co-authored three textbooks. My most recent presentations at the Annual NCTM Meeting (National Council of Teachers of Mathematics) and at the Advanced Placement National Conference addressed strategies for teaching statistical inference.

Selected Publications

How to Prepare for the AP Calculus Examination (with S. Hockett), Barron's, 2002 (7th ed.), 636 pages.

Is That an Assumption or a Condition?, paper posted by The College Board at their APCentral website.

Intro Stats (with R. DeVeaux and P. Velleman), Addison-Wesley, 2003, 567 pages.

Stats: Data and Models (with R. DeVeaux and P. Velleman), Addison-Wesley, 2004, 743 pages.

Stats: Modeling the World (with R. DeVeaux and P. Velleman), Prentice Hall, 2004, 582 pages.

James H. Bramble

Professor Emeritus of Mathematics

For the past 25 years I have been interested in the development of the theoretical foundation of finite-element methods for the approximation of solutions of elliptic and parabolic partial differential equations. Recently I have concentrated on questions concerning rapid solution of large-scale systems that result from such approximations. Such a question is: Among all the theoretically good approximations to a general class of problems, are there some that can be solved efficiently by taking advantage of modern computer architectures such as parallelism? Answers to questions like this one can bring many problems into the realm of practical feasibility. My current research interest is the design of approximations to solutions to problems in partial differential equations that adequately describe the problem and that can be efficiently solved using modern computing power.

Selected Publications

A locking-free finite element method for Naghdi shells (with T. Sun), J. Comp. and Applied Math. **89** (1997), 119–133.

Least squares for second order elliptic problems (with R. Lazarov and J. Pasciak), Comp. Meth. Appl. Eng. **152** (1998), 195–210.

Non-overlapping domain decomposition algorithms with inexact solves (with J. Pasciak and A. Vassilev), Math. Comp. **67** (1998), 1–20.

A negative-norm least squares method for Reissner-Mindlin plates (with T. Sun), Math. Comp. **67** (1998), 901–916.

Multigrid Methods; in Handbook for Numerical Analysis (with X. Zhang), P. Ciarlet and J. Lions, eds., North Holland, 250 pages.

Tara Brendle

VIGRE Assistant Professor of Mathematics

My interests include all topics related to the mapping class group Mod(*S*) of surface *S*. Recently I have focused on two particular subgroups of Mod(*S*): the Torelli group, which is the normal subgroup of Mod(*S*) made up of maps acting trivially on the homology of the surface *S*, and the handlebody group, consisting of those elements of Mod(*S*) which extend to a handlebody whose boundary is *S*. Both subgroups of Mod(*S*) play an important role in many branches of topology and geometry, including the study of homology 3-spheres and Heegaard splittings of 3-manifolds.

Selected Publications

On the linearity problem for mapping class groups (with Hessam Hamidi-Tehrani), Algebraic and Geometric Topology **1** (2001), 445–468.

Every mapping class group is generated by 6 involutions (with B. Farb), Journal of Algebra (to appear).

Braids and knots (with J. Birman); in Handbook of Knot Theory (W. Menasco and M. Thistlethwaite, eds.), to appear.

Commensurations of the Johnson kernel (with D. Margalit), arXiv:math.GT/0404445.

Nathan Broaddus

H. C. Wang Assistant Professor of Mathematics

I am interested in the topology and geometry of 3-manifolds. In particular I am interested in algorithmic problems arising from 3-manifolds.

Kenneth Brown

Professor and Chair of Mathematics

My main interests have been algebra and topology. I have especially enjoyed using topological methods to study infinite discrete groups. In some of my early work, for instance, I studied Euler characteristics of groups. I obtained formulas relating the Euler characteristic (a topological concept) to purely algebraic properties of groups. When applied in special cases, these formulas unexpectedly led to new results in algebraic number theory. Later, I found topological methods for studying two interesting families of groups: infinite simple groups, and groups that can be presented by means of a complete rewriting system.

My work has recently had unexpected applications to probability theory. I have used methods of algebra and topology to analyze an interesting family of random walks.

Selected Publications

Euler characteristics of discrete groups and G-spaces, Invent. Math. **27** (1974), 229–264.

Cohomology of Groups, Graduate Texts in Mathematics **87**, Springer-Verlag, New York, 1982.

Buildings, Springer-Verlag, New York, 1989.

Semigroups, rings and Markov chains, J. Theoret. Probab. **13** (2000), 871–938.

Forest diagrams for elements of Thompson's group F (with James Belk), Internat. J. Algebra Comput. (to appear).

Kai-Uwe Bux

H. C. Wang Assistant Professor of Mathematics

The underlying idea of geometric group theory is that groups are meant to act on geometric objects. The properties of the action can be used to study both the group and the geometry. From this point of view, the first step in understanding a group is to find a space on which it acts "nicely." Classical examples of this technique include the work on arithmetic and *S*-arithmetic groups by means of buildings and symmetric spaces, the study of mapping class groups via Teichmüller theory, and the results about outer automorphism groups of free groups via their actions on Culler-Vogtmann spaces.

Once a space X and an action $G \to \mathrm{Aut}(X)$ are chosen, there is still the problem of understanding the space. In this context, combinatorial Morse theory is an important tool: If there is a real-valued function $f : X \to \mathbf{R}$ on the space, whose level sets are invariant with respect to the group action, then the homotopy type of the space and of the sublevel sets $f^{-1}(-\infty, t)$ can be understood in terms of incremental changes as the value of t varies.

I have applied some of these ideas to solvable *S*-arithmetic groups over global function fields in order to determine their finiteness properties and geometric invariants — finiteness properties and geometric invariants extend and refine the notions of finite generation and finite presentability of groups.

Selected Publications

Finiteness properties of some metabelian S-arithmetic groups, Proceedings of the London Mathematical Society **75** (1997), 308–322.

The Bestvina-Brady construction revisited — geometric computation of Σ-invariants of right-angled Artin groups (with C. Gonzalez), Journal of the London Mathematical Society (2) **60** (1999), 793–801.

Orbit spaces of subgroup complexes and Morse theory, Topology Proceedings **24** (Spring 1999), 39–51.

Finiteness properties of soluble S-arithmetic groups — a survey; in Proceedings of the conference "Groups: Geometric and Combinatorial Aspects," Bielefeld, 1999, to appear.

Kariane Calta

H. C. Wang Assistant Professor of Mathematics

My research involves the dynamics of the geodesic flow on translation surfaces, i.e. 2-manifolds whose transition functions are translations. I am also interested in the orbit structures of these surfaces in the moduli space of abelian differentials. Some of my research has applications to the study of billiards.

Selected Publications

Veech surfaces and complete periodicity in genus two, JAMS (to appear).

Stephen U. Chase

Professor of Mathematics

With the exception of my early work on module theory, homological algebra, and abelian groups, the enduring theme of my mathematical interests and research has been the Galois theory of rings and fields, and variations of these theories in which the role of the classical Galois group is played by some related algebraic structure such as a restricted Lie algebra, group scheme, Hopf algebra, or groupoid. This work impinges upon and utilizes techniques from other areas in which I also have strong interests, such as category theory and homological algebra, group theory, group schemes and Hopf algebras, representation theory, algebraic K-theory, and algebraic number theory.

Following a period in my career in which the main focus of my research was the Galois module structure of algebraic integers, I have returned to investigations in pure algebra; these involve primarily Hopf algebras (especially quantum groups and Tannakian reconstruction) and, more recently, finite groups (especially the structure of p-groups).

Selected Publications

Galois theory and Galois cohomology of commutative rings (with D. K. Harrison and A. Rosenberg), Amer. Math. Soc. Memoir **52** (1965).

Hopf algebras and Galois theory (with M. E. Sweedler), Lecture Notes in Math **97**, Springer-Verlag, 1969.

Infinitesimal group scheme actions on finite field extensions, Amer. J. Math. **98** (1976), 441–480.

Ramification invariants and torsion Galois module structure in number fields, J. Algebra **91** (1984), 207–257.

Indira Chatterji

H. C. Wang Assistant Professor of Mathematics

I am interested in topics related to the idempotent conjecture, which is that the only idempotents in the group ring of a torsion-free group should be 0 and 1. This conjecture has a generalization to the rings $\ell^1(G)$ or $C^*_{r(G)}$, and can be solved in some geometric cases using methods from topology (Baum-Connes conjecture).

Selected Publications

Property (RD) for cocompact lattices in a finite product of rank one Lie groups with some rank two Lie groups, Geometriae Dedicata **96** (2003), 161–177.

From acyclic groups to the Bass conjecture for amenable groups (with J. Berrick and G. Mislin), FIM preprint 2002, submitted.

Atiyah's L^2-index theorem (with G. Mislin), Enseignement Mathematique, to appear.

Hsiao-Bing Cheng

VIGRE Assistant Professor of Mathematics

I am primarily interested in the study of parabolic geometric flows, and in particular, the Ricci and Mean Curvature flows. Much like the heat flow, these flows often have a "smoothing" effect and can thus be used to help find "simple" or canonical geometries on a given space.

Parabolic flows are also used extensively for numerical computations which are geometric in nature.

Marshall M. Cohen

Professor Emeritus of Mathematics

I am a geometric topologist and a combinatorial group theorist. Much of my work has dealt with the introduction of combinatorial and algebraic themes into geometric problems or geometric themes into combinatorial and algebraic problems. Over the years this work has involved the intermingling of topological manifolds, combinatorial topology, the foundations of piecewise linear topology, simple-homotopy theory, automorphisms of free groups, spaces of length functions on groups and equations over groups. Currently the second best description of me is as a geometric group theorist.

The title I most covet is that of teacher. The writing of a research paper and the teaching of freshman calculus, and everything in between, falls under this rubric. Happy is the person who comes to understand something and then gets to explain it.

In addition to research and teaching I deeply enjoy my role as faculty advisor to undergraduates.

Selected Publications

Simplicial structures and transverse cellularity, Annals of Math. (2) **85** (1967), 218–245.

A Course in Simple-Homotopy Theory, Graduate Texts in Mathematics **10**, Springer Verlag, 1973.

On the dynamics and the fixed subgroup of a free group automorphism (with Martin Lustig), Inv. Math. **96** (1989), 613–638.

Very small group actions on R-trees and Dehn twist automorphisms (with Martin Lustig), Topology **34** (1995), 575–617.

The surjectivity problem for one-generator, one-relator extensions of torsion-free groups (with Colin Rourke), Geometry and Topology **5** (2001), 127–142.

Robert Connelly

Professor of Mathematics

Discrete geometry, with emphasis on the geometry of rigid and flexible structures, is my main area of interest. A tensegrity is a structure composed of sticks held in mid-air with strings that, nevertheless, holds its shape. This can be modeled very nicely as a configuration of points with upper and lower bounds on the distances between certain pairs of points. This in turn leads to interesting problems in, and applications to, distance geometry and the theory of packings and coverings of spheres as well as applications to robotics, protein folding, motion planning and percolation problems in physics and probability.

Another subject of interest is the theory of flexible surfaces. There are triangulated surfaces that flex, keeping their edges at a fixed length, and it has recently been shown that such surfaces maintain a fixed volume while they flex. There is no perfect mathematical bellows. This is also related to a polynomial that relates the volume of the surface to the lengths of its edges. This is at the intersection of discrete geometry, algebraic geometry and topology.

Selected Publications

Mathematics and tensegrity (with A. Back), American Scientist March-April (1998), 142–151.

Tensegrity structures: Why are they stable?; in Rigidity Theory and Applications (M. F. Thorpe and P. M. Duxbury, eds.), Kluwer Academic/Plenum, 1999, pp. 47–54.

The Kneser-Poulsen conjecture (with K. Bezdek), Crelle's Journal, J. reine angew. Math. **553** (2002), 221–236.

The Kneser-Poulsen conjecture for spherical polytopes (with K. Bezdek), submitted.

Straightening polygonal arcs and convexifying polygonal cycles (with E. Demaine and G. Rote), in preparation.

Barbara Csima

H. C. Wang Assistant Professor of Mathematics

My research falls into two main areas: computable model theory, and computability theory questions arising from differential geometry.

In computable model theory, we examine the complexity of theorems in model theory using tools from computability theory. I have been particularly interested in studying the Turing degrees of prime models of complete atomic decidable theories.

Recent results in differential geometry have shown a connection between the settling times of computably enumerable (c.e.) sets and the depth and distribution of local minima in the space of Riemannian metrics on a smooth compact manifold, modulo diffeomorphisms. I have been working on showing the existence of sequences of c.e. sets whose settling times behave in a way that has interpretations in differential geometry. I have also been examining properties of c.e. sets related to their settling times.

Selected Publications

Degree spectra of prime models, J. Symbolic Logic **69** no. 2 (2004), 430–442.

Bounding prime models (with D. R. Hirschfeldt, J. F. Knight, and R. I. Soare), J. Symbolic Logic, submitted.

Sarah Day

VIGRE Assistant Professor of Mathematics

I have been working mainly in the area of rigorous numerical techniques for dynamical systems. In particular, I am interested in methods based on an algebraic topological tool called the Conley index. These methods have been used with a number of systems to prove the existence of dynamical objects from fixed points to chaotic attractors. Currently, I am investigating extensions to a wider class of problems in dynamical systems, including bifurcation analysis as well as applications to the study of biological models.

Selected Publications

Towards a rigorous numerical study of the Kot-Schaffer model, Dynamic Systems and Applications **12** no. 1–2 (2003), 87–98.

A rigorous numerical method for the global analysis of infinite dimensional discrete dynamical systems (with O. Junge and K. Mischaikow), SIAM Journal on Applied Dynamical Systems (to appear).

Towards automated chaos verification (with O. Junge and K. Mischaikow), Proc. Equadiff 2003 (to appear).

Rigorous numerics for global dynamics: a study of the Swift-Hohenberg equation (with Y. Hiraoka, K. Mischaikow, and T. Ogawa), submitted.

R. Keith Dennis

Professor of Mathematics

Most of my research has been in the field of algebraic *K*-theory. This field is, in some sense, a fancy generalization of linear algebra to arbitrary rings. As such, it has applications in many other areas of mathematics such as topology, algebraic geometry, and even the theory of Markov processes. I have been most interested in the computational aspects of the subject, in particular, the computation of quotients of rings of algebraic integers and in the computation of the Whitehead group for finite abelian groups.

Parts of this work have involved the use of computers to understand a number of examples before formulating and proving the general results. This work has led to the study of questions about group rings, number theory, and theory of finite groups. My current interest lies in studying a number of problems relating to commutators, structure, and invariants of finite groups which can be investigated by computer computations.

While I was executive editor of *Mathematical Reviews*, I became interested in problems dealing with mathematical communication, databases and mathematical bibliography, and how to convert the older mathematical literature into searchable electronic form. I have mainly been involved with these issues during the last several years.

Selected Publications

Recent developments in digital library technologies (with G. O. Michler, M. Suzuki and G. Schneider); in DIAR-03: Workshop on Document Image Analysis and Retrieval, to appear.

Computation of the Scharlau invariant (with Paul Young), in preparation.

Homogeneous functions and algebraic K-theory (with R. Laubenbacher), in preparation.

The number of groups of order n, in preparation.

Generic product decompositions of finite groups, in preparation.

Martin Dindos

H. C. Wang Assistant Professor of Mathematics

Harmonic analysis is one of the pillars of modern PDE theory. In fact, most of the problems harmonic analysis deals with have their origins in PDEs. In return, harmonic analysis substantially contributes to the development of PDE by providing sharp and refined techniques such as pseudodifferential operators, singular and oscillatory integrals, etc.

For this reason, in my research I am sometimes interested in questions that originate purely in harmonic analysis, such as my Ph.D. thesis Hardy spaces and potential theory on C^1 domains in Riemannian manifolds that I wrote under Michael Taylor (UNC). In other instances I use harmonic analysis techniques to study PDE problems. (See the last two papers below.)

Harmonic analysis is particularly well suited for studying PDE on rough domains, i.e., domains whose boundary is not smooth. So far most work in this direction was done for linear elliptic PDEs. I am particularly interested in nonlinear problems, which still remain a great challenge.

Selected Publications

Filippov implicit function theorem for Quasi-Caratheodory functions (with V. Toma), Journal of Mathematical Analysis and Applications **214** (1997), 475–481.

On series with alternating signs in the Euclidean metric, Real Analysis Exchange **25** no. 2 (1999/2000), 599–616.

Existence and uniqueness for a semilinear elliptic problem on Lipschitz domains in Riemannian manifolds, Comm. PDE **27** (2002), 219–291.

Existence and uniqueness for a semilinear elliptic problem on Lipschitz domains in Riemannian manifolds II, Trans. AMS **355** (2003), 1365–1399.

Semilinear Poisson problems in Sobolev-Bessov spaces on Lipschitz domains (with M. Mitrea), Publicacions Mathematiques, submitted.

Richard Durrett

Professor of Mathematics

My initiation to work at the interface between mathematics and biology came from a collaboration with Simon Levin that was begun in the late 80's and produced 10 pages on the use of stochastic spatial models in ecology.

In 1997 I began a collaboration with Chip Aquadro in Molecular Biology and Genetics at Cornell. Our first paper on the evolutionary dynamics of DNA repeat sequences (e.g., CA repeated 15 times in a row) was published in the Proceedings of the National Academy of Science. Subsequent work with two graduate students has shown that the dependence of mutation rates on length of repeat is not simple and selection acts to reduce the length of long repeats.

With Rasmus Nielsen in Biological Statistics and Computational Biology, I am developing stochastic methods for studying the evolution of genomes due to large-scale processes: inversions within chromosomes, translocations between chromosomes, chromosomal fissions and fusions, and gene duplication. This work has led to a surprising new result on the behavior of the distance from the origin for random walk on the transposition group.

On my own I have studied the influence of spatial structure on genealogies and developed a simple approximation for the effect of fixation of advantageous mutations on the variability of nearby nucleotides.

In the summer of 2003 I worked with six students in the REU program. Two papers were written with REU students Rachel Ward and Jonah Blasiak. Elizabeth Rach did an honors thesis based on that work and will enroll in an interdisciplinary program at Duke in the fall. The first part of Deena Schmidt's Ph.D. thesis traces its origin to her work with the summer program.

Selected Publications

Dinucleotide repeats in the Drosophila and human genomes have complex length dependent mutation processes (with P. Calabrese), Mol. Biol. Evol. **20** (2003), 715–725.

Bayesian estimation of genomic distance (with R. Nielsen and T.L. York), Genetics **166** (2004), 621–629.

Microsatellite models: Insights from a comparison of humans and chimpanzees (with R. Sainudiin, C.F. Aquadro, and R. Nielsen), Genetics (to appear).

The stepping stone model, II. Genealogies and the infinite sites model (with I. Zahle and J.T. Cox), Ann. Appl. Probab. (to appear).

Approximating selective sweeps (with J. Schweinsberg), Theor. Pop. Biol. (to appear) and Ann. Appl. Probab. (submitted).

Subfunctionalization: How often does it occur? How long does it take? (with R. Ward), Theor. Pop. Biol. (to appear).

A phase transition in the random transposition random walk (with N. Berestycki), Prob. Theory Rel. Fields (submitted).

Adaptive evolution drives the diversification of zinc-finger binding domains (with D. Schmidt), Mol. Biol. Evol. (submitted).

Random Oxford graphs (with J. Blasiak), in preparation.

Eugene B. Dynkin

Professor of Mathematics and A. R. Bullis Chair

Lie groups were the main subject of my earlier research. Dynkin's Diagrams are widely used by mathematicians and physicists. After 1954, probability theory became the central field of my interests. Principal efforts were devoted to Markov processes and their connections with potential theory and partial differential equations. Other work includes research in mathematical statistics (sufficient statistics, exponential families), optimal control (optimal stopping, control with incomplete data) and mathematical economics (economic growth and economic equilibrium under uncertainty).

In the 80s I worked on the relationship between Markov processes and random fields that arise in statistical physics and quantum field theory. One of the results — an isomorphism theorem connecting Gaussian fields with local times for Markov processes — has a considerable impact on the work of a number of investigators. For the last decade, my main efforts are devoted to the theory of measure-valued branching processes. (The name *superprocesses* suggested by me for these processes is now standard in mathematical literature.) Connections between superdiffusions and a class of nonlinear partial differential equations were established that makes it possible to apply powerful analytic tools for investigating the path behavior of superdiffusions, and that provides a new probabilistic approach to problems of nonlinear PDEs. New directions — the description of all positive solutions of a certain class of nonlinear equations and the study of removable boundary singularities of such solutions — have been started in a series of joint papers of Dynkin and Kuznetsov. A theory developed by them and by a number of other investigators is presented in a systematic way in a recent monograph of Dynkin.

The complete classification of positive solutions of nonlinear equations $\Delta u = u^{\alpha}$ with $1 < \alpha \leq 2$ in a bounded smooth domain resulted from a series of papers by Dynkin and by Dynkin and Kuznetsov written in 2003. A systematic presentation of these results is contained in a forthcoming book of Dynkin.

Selected Publications

An Introduction to Branching Measure-Valued Processes, CRM Monograph Series **6**, American Mathematical Society, Providence, RI, 1994.

Fine topology and fine trace on the boundary associated with a class of semilinear differential equations (with S. E. Kuznetsov), Comm. Pure and Appl. Math. **51** (1998), 897–936.

Selected Papers of E. B. Dynkin with Commentary, Amer. Math. Soc. and International Press, 2000.

Diffusions, Superdiffusions and Partial Differential Equations, AMS Colloquium Publications, Vol. 50, Providence, Rhode Island, 2002.

Superdiffusions and positive solutions of nonlinear partial differential equations, American Mathematical Society, 2004 (forthcoming book).

Clifford J. Earle

Professor of Mathematics

Most of my research concerns invariants belonging to Riemann surfaces. I am especially interested in learning how these invariants change when the complex structure of the Riemann surface is modified. A useful technique is to consider a family of Riemann surfaces depending holomorphically on some parameters and to study how the invariants of the surface change as we move about in the parameter space. Quasiconformal maps and Kleinian groups have proved to be fundamental tools for the construction of good parameter spaces, so I have studied and used them extensively.

Selected Publications

A fibre bundle description of Teichmüller theory (with J. Eells, Jr.), J. Diff. Geom. **3** (1969), 19–43.

Families of Riemann surfaces and Jacobi varieties, Ann. Math. **107** (1978), 255–286.

Conformally natural extension of homeomorphisms of the circle (with A. Douady), Acta Math. **157** (1986), 23–48.

Holomorphic motions and Teichmüller spaces (with I. Kra and S. L. Krushkal), Trans. Amer. Math. Soc. **343** (1994), 927–948.

Geometric isomorphisms between infinite dimensional Teichmüller spaces (with F. P. Gardiner), Trans. Amer. Math. Soc. **348** (1996), 1163–1190.

José F. Escobar

Professor of Mathematics

My research has focused on the study of linear and non-linear partial differential equations arising in differential geometry. The basic purpose of geometry is to give a good description of a class of geometric objects. The geometric objects I study are the so-called Riemannian manifolds. These are spaces endowed with analytical structures, like the metric, which provide us with a way to measure lengths and angles. It is natural to study deformations of these structures to realize what properties in the space remain stable under such perturbations. The description of all these deformations is usually governed by differential equations. The curvature tensor of a Riemannian manifold (a measure for the "non-Euclideanness" of a Riemannian space) usually makes such equations non-linear, although as in physics, most of them are of variational nature. I have been able to develop the existence theory of solutions to semilinear elliptic equations with non-linear boundary conditions. These equations appear in the problem of conformal deformation of a Riemannian metric on a manifold with boundary and in some non-linear problems in physics.

Selected Publications

The Yamabe problem on manifolds with boundary, J. Diff. Geom. **25** (1992), 21–84.

Conformal deformation of a Riemannian metric to a scalar flat metric with constant scalar curvature, Annals of Mathematics **136** (1992), 1–50.

Conformal deformation of a Riemannian metric to a constant scalar curvature metric with mean curvature on the boundary, Indiana U. Math. J. **45** no. 4 (1996), 917–943.
An isoperimetric inequality and the first Steklov eigenvalue, J. Func. Anal. **165** (1999), 101–116.
Conformal metrics on the ball with zero scalar curvature and prescribed mean curvature on the boundary, Journal of Functional Analysis, to appear.

Roger H. Farrell

Professor Emeritus of Mathematics

Retired as of July 1, 1999, I am still semi-active in the department and try to come in most days to audit classes and work some in the Math Support Center. I am not active in research.

My research concerned the application of decision theory methods to statistical problems to try and characterize completely good and bad methods of estimation and testing. Useful decision theory methods can involve development of inequalities, compactification of spaces, and study of the way sequences of measures converge.

Selected Publications

Proof of a necessary and sufficient condition for admissibility in discrete multivariate problems (with L. D. Brown), J. Mult. Annal. **24** (1988), 46–52.
All admissible linear estimators of the vector of gamma state parameters with application to random effects models (with W. Klonecki and S. Zontek), Ann. Statist. **17** (1989), 268–281.
A lower bound for the risk in estimating the value of a probability density (with L. D. Brown), Jour. Amer. Statist. Assoc. **85** (1990), 1147–1153.
Estimations of accuracy in testing (with J. T. G. Hwang, G. Casella, C. Robert and M. T. Wells), Ann. Statist. **20** (1992), 490–509.
Spitzer and Bohnenblust, revisited (1997), preprint.

Matthew Fickus

VIGRE Assistant Professor of Mathematics

The field of harmonic analysis is composed of many branches. In the same way one may decompose a harmony into pure tones, linear algebra provides a formalism for breaking vectors apart into basis elements. My interests lie in further developing the theory of bases in both the pure and applied (signal processing) setting.

Specifically, I am studying bases of complex exponential functions on fractal measures with the goal of generalizing Fourier series. I also am interested in frames, a way of performing basis-type decompositions that allow redundancy. My hope is that redundant frame decompositions may be used to build error correction directly into Fourier and wavelet transforms, and thus help bridge the gap between channel and source coding.

Selected Publications

Finite normalized tight frames (with J. Benedetto), Advances in Computational Mathematics **18** (2003), 357–385.

Leonard Gross

Professor of Mathematics

My research could, for the most part, be described as analysis over infinite dimensional spaces. This has sometimes been motivated by problems of mathematical physics, specifically statistical mechanics and the problem of existence of quantum fields. There is usually a naturally arising probability measure on the infinite dimensional space of interest to me that links functional analytic questions to probability theory. In the early 1990s I studied properties of the Dirichlet form associated to pinned Brownian motion on loop groups. A long-range goal was proof of a Hodge-deRham theorem for these manifolds of maps. More recently, I have studied Dirichlet forms in holomorphic function spaces over a complex manifold and their link to a strong kind of hypercontractivity.

Selected Publications

Existence and uniqueness of physical ground states, J. Func. Anal. **10** (1972), 52–109.
Logarithmic Sobolev inequalities, American J. Math. **97** (1975), 1061–1083.
Uniqueness of ground states for Schrödinger operators over loop groups, J. Func. Anal. **112** (1993), 373–441.
Hypercontractivity over complex manifolds, Acta Math. **182** (1999), 159–206.
Holomorphic Dirichlet forms on complex manifolds (with Z. Qian), Math. Z. **246** (2004), 521–561.

John M. Guckenheimer

Professor of Mathematics

Dynamical systems theory studies long time behavior of systems governed by deterministic rules. Even the simplest nonlinear dynamical systems can generate phenomena of bewildering complexity. Formulas that describe the behavior of a system seldom exist. Computer simulation is the way to see how initial conditions evolve for particular systems. In carrying out simulations with many, many different systems, common patterns are observed repeatedly. One of the main goals of dynamical systems theory is to discover these patterns and characterize their properties. The theory can then be used as a basis for description and interpretation of the dynamics of specific systems. It can also be used as the foundation for numerical algorithms that seek to analyze system behavior in ways that go beyond simulation. Throughout the theory, dependence of dynamical behavior upon system parameters has been an important topic. Bifurcation theory is the part of dynamical systems theory that systematically studies how systems change with varying parameters.

My research is a blend of theoretical investigation, development of computer methods and studies of nonlinear systems that arise in diverse fields of science and engineering. Much of the emphasis is upon studying bifurcations. The computer package DsTool is a product of the research of former students and myself with additional contributions from postdoctoral associates. It provides an efficient interface for the simulation of dynamical models and incorporates several additional algorithms for the analysis of dynamical systems. The program is freely available, subject to copyright restrictions. My current work focuses upon the dynamics of systems with multiple time scales, algorithm development for problems involving periodic orbits and upon applications to the neurosciences, animal locomotion and control of nonlinear systems.

Selected Publications

Nonlinear Oscillations, Dynamical Systems and Bifurcation of Vector Fields (with P. Holmes), Springer-Verlag, 1983, 453 pp.

Phase portraits of planar vector fields: computer proofs, J. Experimental Mathematics **4** (1995), 153–164.

An improved parameter estimation method for Hodgkin-Huxley model (with A. R. Willms, D. J. Baro and R. M. Harris-Warrick), J. Comp. Neuroscience **6** (1999), 145–168.

Computing periodic orbits and their bifurcations with automatic differentiation (with B. Meloon), SIAM J. Sci. Stat. Comp. **22** (2000), 951–985.

The forced van der Pol equation I: the slow flow and its bifurcations (with K. Hoffman and W. Weckesser), SIAM J. App. Dyn. Sys. **2** (2002), 1–35.

Allen Hatcher

Professor of Mathematics

A common thread through much of my research is the idea of studying the space of all topological objects of a certain kind, for example, the space of all finite polyhedra, the space of all diffeomorphisms of a manifold, or the space of all knots. Recently I have also been writing a couple of graduate-level textbooks in topology.

Selected Publications

Higher simple homotopy theory, Annals of Math. **102** (1975), 101–137.

A proof of the Smale conjecture, Annals of Math. **117** (1983), 553–607.

Algebraic Topology, Cambridge University Press, 2002. (This book is also available online at www.math.cornell.edu/~hatcher.)

Timothy J. Healey

Professor and Chair of Theoretical and Applied Mechanics

I work at the interface between nonlinear analysis of pde's — mostly elliptic systems — and the mechanics of elastic structures and solid continua. Nonlinear (finite) elasticity is the central model of continuum solid mechanics. It has a vast range of applications, including flexible engineering structures, biological structures — both macroscopic and molecular, and materials like elastomers and shape-memory alloys — everything from fighter jets to lingerie! Although the beginnings of the subject date back to Cauchy, the current state of existence theory is quite poor; properly formulated problems of the subject are often out of the range of present day mathematics. In other words there are many open problems.

My work ranges from the abstract — e.g., developing a generalized nonlinear Fredholm degree to obtain solutions "in the large" in 3-D nonlinear elasticity — to the more concrete — e.g., modeling the helical microstructure of DNA in elastic rod models. Most recently I have become quite interested in the analysis of elastic surfaces in models inspired by "biological membranes."

Selected Publications

Global continuation in nonlinear elasticity (with H. Simpson), Arch. Rat. Mech. Anal. **143** (1998), 1–28.

Global continuation in displacement problems of nonlinear elastostatics via the Leray-Schauder degree, Arch. Rat. Mech. Anal. **152** (2000), 273–282.

Global continuation via higher-gradient regularization and singular limits in forced one-dimensional phase transitions (with H. Kielhöfer), SIAM J. Math. Anal. **31** (2000), 1307.

Material symmetry and chirality in nonlinearly elastic rods, Math. Mech. Solids 7 (2002), 405–420.

Global bifurcation in nonlinear elasticity with an application to barrelling states of cylindrical columns (with E. Montes), J. Elasticity **71** (2003), 33–58.

David W. Henderson

Professor of Mathematics

There is a huge crisis in the teaching and learning of mathematics in the world — this crisis is affecting the future of mathematics. My work on mathematics is having an impact on this crisis by stressing that teachers (and thence their students) learn and experience ways of thinking that are as close as possible to the ways that mathematician's think, but yet simultaneously paying attention to the cognitive development of students and teachers and the underlying meanings and intuitions of the mathematics. Only mathematicians can do this work, thus the term "Educational Mathematics." My main thesis is that we should enliven our conception of what "proof" is and that proofs should be a central part of mathematics teaching at all levels, where my definition of "proof" is: *A convincing communication that answers — Why.*

In addition, I am currently involved in extensive curriculum innovation projects in undergraduate mathematics. My first book, *Experiencing Geometry on Plane and Sphere* (Prentice-Hall, 1996), has been requested by faculty in over 50 countries and has been translated into Portuguese. My second book is *Differential Geometry: A Geometric Introduction* (Prentice-Hall, 1998). My third book, *Experiencing Geometry: in Euclidean, Spherical and Hyperbolic Spaces* (with Daina Taimina; Prentice-Hall, 2001), is an extensive revision and expansion of my first book. My fourth book, *Experiencing Geometry: Euclidean, Non-Euclidean with Strands of History* (with Daina Taimina; Prentice-Hall, published 2004, copyright 2005) is a further expansion and revision. Other books are in process.

Selected Publications

I learn mathematics from my students — multiculturalism in action, For the Learning of Mathematics **16** no. 2 (1996).

Crocheting the hyperbolic plane (with Daina Taimina), Mathematical Intelligencer **23** no. 2 (2001), 17–28.

Review of Geometry: Euclid and Beyond by Robin Hartshorne, Bulletin of the AMS **39** (2002), 563–571.

How to use history to clarify common confusions in geometry (with Daina Taimina), a chapter in *Using Recent History in the Teaching of Mathematics* (A. Shell and D. Jardine, eds.), MAA Notes, publication expected fall 2004.

Experiencing Meanings in Geometry (with Daina Taimina), a chapter in *Aesthetics and Mathematics* (D. Pimm and M. Sinclair, eds.), Springer-Verlag, publication expected in 2004.

John H. Hubbard

Professor of Mathematics

Differential equations are the main way in which mathematical models of real systems are constructed, and understanding their behavior is the main contribution a mathematician can make to applications. I am interested in understanding the behavior of differential equations and their close relatives: iterative systems. In particular, I try to see how such systems behave in the complex domain, largely because complex analysis brings new and powerful techniques to bear on the problems.

The availability of powerful computers and computer graphics has changed the way this sort of research is done. In the course of investigations of even such simple iterative systems as quadratic polynomials, amazing pictures show up, rather as artifacts to be investigated than as man-made objects. I anticipate that this sort of experimental mathematics will become a major trend.

Most of my research over the last five years has been devoted to dynamics in several complex variables. I have co-authored four foundational papers in the field. I am also writing three books on a very advanced level, one giving a treatment of Teichmüller space and its applications in theorems of Bill Thurston, the second on dynamics of one complex variable, and the third on differential geometry.

Selected Publications

Differential Equations, A Dynamical Systems Approach Part I (with Beverly West), Texts in Applied Mathematics No. 5, Springer-Verlag, NY, 1991.

Differential Equations, A Dynamical Systems Approach: Higher Dimensional Systems (with Beverly West), Texts in Applied Mathematics No. 18, Springer-Verlag, NY, 1995.

Vector Calculus, Linear Algebra and Differential Forms, A Unified Approach (with Barbara Burke Hubbard), 2nd edition, Prentice Hall, 2002.

Student Solution Manual to Accompany Vector Calculus, Linear Algebra and Differential Forms, A Unified Approach; Matrix Editions (with Barbara Burke Hubbard), 2002.

J. T. Gene Hwang

Professor of Mathematics

Recently, I started to focus mainly on the theory of statistical intervals. Statistical intervals, such as confidence intervals, prediction intervals and tolerance intervals are one of the major areas in statistics. By providing intervals, statisticians demonstrate the possible range of the interested parameters or future observations.

Much of my research is stimulated by scientific and engineering applications. Although my primary interest is in theory, the solutions often can be used directly in application. My recent joint work with the National Institute of Standards and Technology is one example.

Selected Publications

Optimal confidence sets, bioequivalence and the limacon of Pascal (with L. D. Brown and G. Casella), JASA **90** (1995), 880–890.

Maximum likelihood estimation under order restricted parameters by the prior feedback method (with C. Robert), JASA **91** (1996), 167–172.

An unbiased test for the bioequivalence problem (with L. D. Brown and Axel Munk), Ann. Stat. **25** (1997), 2345–2367.

Prediction intervals in artificial neural network (with A. Adam Ding), JASA **92** (1997), 748–757.

Prediction intervals, factor analysis models and high-dimensional empirical linear prediction (HELP) (with A. Adam Ding), JASA, to appear.

Yulij Ilyashenko

Professor of Mathematics

My research interests are several branches of dynamical systems, both in real and complex domains. They include: limit cycles in real and complex planes; analytic differential equations, with relations to complex analysis and algebraic geometry; local and nonlocal bifurcations and so on. Some main objects to study are: (1) Limit cycles of polynomial vector fields in the real plane. For instance, in *Finiteness Theorems for Limit Cycles*, I proved that for a *fixed* polynomial vector field the number of limit cycles is finite. (2) Geometric properties of foliations determined by analytic vector fields in the complex plane. (3) Bifurcations of planar polycycles (separatrix polygons). (4) New nonlocal bifurcations in higher-dimensional spaces, and many others.

Selected Publications

Finiteness Theorems for Limit Cycles, Amer. Math. Soc., Transl. Vol. 94, 1991, 288 pp.

Editor of *Nonlinear Stokes Phenomena*, Advances in Soviet Mathematics, Vol. 14, Amer. Math. Soc., 1993.

Editor of *Concerning Hilbert's 16th Problem* (with Yakovenko), Amer. Math. Soc., 1995, 219 pp.

Editor of *Differential Equations with Real and Complex Time*, a collection of papers, proceedings of the Steklov Institute, Vol. 213, 1996.

Nonlocal Bifurcations (with Li Weigu), Mathematical Surveys and Monographs **66**, Amer. Math. Soc., 1998.

Paul Jung

VIGRE Assistant Professor of Mathematics

My research area is the subdiscipline of stochastic processes called interacting particle systems. In particular I am interested in the ergodic or long-run behavior of these processes. Many of these issues are motivated by problems arising in statistical mechanics. Recently, I am interested in the application of these processes to ecology and biology.

Selected Publications

Extremal reversible measures for the exclusion process, Journal of Statistical Physics (July 2003).

The noisy voter-exclusion process, Stochastic Processes and Applications (to appear).

Perturbations of the symmetric exclusion process, Markov Processes and Related Fields (to appear).

Adding edges to the contact process, submitted for publication.

Peter J. Kahn

Professor of Mathematics

For the past few years, I have been working in the area of symplectic topology. My current interests include various existence and classification questions concerning symplectic forms on the total spaces of symplectic fibrations.

Selected Publications

Pseudohomology and homology (Nov. 2001), 35 pp.

Symplectic torus bundles and group extensions (Apr. 2004), 18 pp.

Martin Kassabov

H. C. Wang Assistant Professor of Mathematics

My research interests fall into two main categories: (1) representation theory of discrete groups and Kazhdan property T, and (2) combinatorial algebra —

applications of different combinatorial methods in abstract algebra. During the last few years, we have seen the successful transfer of ideas from one field to the other.

The main part of my research is related to Kazhdan property T. The conceptual way to define this property is to say that a group has Kazhdan property T if and only if its trivial representation is an isolated point in the family of all unitary irreducible representations, with respect to the Felt topology. This property arises from the study of the infinite dimensional representations of arithmetic groups.

Another part of my research can be broadly described as combinatorial algebra. This subject comprises numerous subfields. My research interests are concentrated in the following topics: automorphism groups, Golod-Shafarevich groups, group rings, and geometric applications.

Harry Kesten

Professor Emeritus of Mathematics

I am a probabilist. My main research interests are percolation theory and random walks, and in general I like to dabble in models inspired by statistical mechanics.

One model I have recently worked on can be viewed as a model for the spread of a rumor. There are two kinds of particles, *A*-particles (corresponding to the people in the know) and *B*-particles (people who have not heard the rumor). The *A*-particles perform independent (continuous time) random walks on $\mathbf{Z}^d$ with distribution F_A and similarly the *B*-particles perform independent random walks with distribution F_B. The only interaction between all the particles is that when a *B*-particle meets an *A*-particle it turns into an *A*-particle and continues forever as an *A*-particle. We start with independent Poisson numbers of *B*-particles at the sites of $\mathbf{Z}^d$ and a single *A*-particle at the origin. How fast does the set of *A*-particles grow with time? In other words, what is the set of people who heard the rumor by time t, for large t? It is expected that this set grows linearly with t, but so far results are known only if $F_A = F_B$, or if the *B*-particles do not move at all.

Selected Publications

Products of random matrices (with H. Furstenberg), Ann. Math. Statist. **31** (1960), 457–469.

Hitting Probabilities of Single Points for Processes with Stationary Independent Increments, Memoir no. 93, Amer. Math. Soc. (1969).

Percolation Theory for Mathematicians, Birkhäuser, Boston, 1982.

Aspects of first-passage percolation; in Ecole d'été de Probabilités de Saint-Flour XIV, (P. L. Hennequin, ed.), Lecture Notes in Math 1180, Springer-Verlag, 1986, pp. 125–264.

On the speed of convergence in first-passage percolation, Ann. Appl. Probab. **3** (1993), 296–338.

Dexter Kozen

Joseph Newton Pew, Jr., Professor in Engineering (Computer Science)

My research interests include the theory of computational complexity, especially complexity of decision problems in logic and algebra, and program logic and semantics. In the past I have worked on algorithms for type inference in programming languages; static analysis of programs; functional decomposition of polynomials and rational and algebraic functions; and algorithms for resolution of singularities. My most recent interests include the theory and applications of Kleene algebra and Kleene algebra with tests (Kleene/Boolean algebra) in programming language semantics and verification.

Selected Publications

Substructural logic and partial correctness (with Jerzy Tiuryn), Trans. Computational Logic **4** no. 3 (2003), 355–378.

KAT-ML: An interactive theorem prover for Kleene algebra with tests (with Kamal Aboul-Hosn); in Proc. 4th Int. Workshop on the Implementation of Logics (B. Konev and R. Schmidt, eds,), University of Manchester, 2003, pp. 2–12.

Automata on guarded strings and applications, Matematica Contemporanea **24** (2003), 117–139.

Computational inductive definability, Annals of Pure and Applied Logic [Special issue: Provinces of logic determined, Essays in the memory of Alfred Tarski, Parts I, II and III (Z. Adamowicz, S. Artemov, D. Niwinski, E. Orlowska, A. Romanowska, J. Wolenski, eds.)] **126** no. 1-3 (2004), 139–148.

Some results in dynamic model theory, Science of Computer Programming [Special issue: Mathematics of Program Construction (E. Boiten and B. Moller, eds.)] **51** no. 1-2 (2004), 3–22.

Gregory F. Lawler

Professor of Mathematics

Most of my research is on random walk and Brownian motion, especially questions arising from statistical physics. A number of questions are inspired by a desire to understand self-avoiding random walk and other random walks with constraints.

Recently, I have been working with Oded Schramm and Wendelin Werner investigating the limit of lattice models that possess certain conformal invariance properties in the continuum limit. This project has produced a number of results, e.g., we have verified a conjecture of Mandelbrot that the Hausdorff dimension of the outer boundary of planar Brownian motion is 4/3.

Selected Publications

Intersections of Random Walks, Birkhäuser-Boston, 1991.

Values of Brownian intersection exponents I and II (with O. Schramm and W. Werner), Acta Mathematica **187** (2001), 237–273, 275–308.

Analyticity of intersection exponents for planar Brownian motion (with O. Schramm and W. Werner), Acta Mathematica **189** (2002), 179–201.

Conformal restriction: the chordal case (with O. Schramm and W. Werner), JAMS **16** (2003), 917–955.

Brownian loop soup (with W. Werner), Probab. Theor. Rel. Fields **128** (2004), 565–588.

G. Roger Livesay

Professor Emeritus of Mathematics

My major area of research is in topology, 3-dimensional manifolds with finite cyclic fundamental groups.

Alexander Meadows

VIGRE Assistant Professor of Mathematics

I am interested in geometric variational problems and nonlinear elliptic partial differential equations. I have been studying the equation $\Delta u = f(u)$, and more specifically the equation $\Delta u = 1/u$. The main focus has been on establishing the existence of continuous singular solutions that are pointwise limits of smooth solutions. Most of the results are consequences of stability for the corresponding variational problem.

Selected Publications

Stable and singular solutions of $\Delta u = 1/u$, preprint, 2003.

A note on free boundary problems for $\Delta u = f(u)$, in preparation, 2003.

Irina Mitrea

H. C. Wang Assistant Professor of Mathematics

My specific interests are in the general areas of real and harmonic analysis and partial differential equations. I am particularly interested in the study of PDE problems arising from mathematical physics with emphasis on the study of fluid dynamics, elasticity and electromagnetism. One of the main themes of my work deals with understanding the nature of the boundary integral operators associated with the aforementioned PDE problems in irregular domains.

Selected Publications

Monogenic Hardy spaces on Lipschitz domains and compensated compactness (with M. Mitrea), Complex Variables Theory Appl. **35** no. 3 (1998), 225–282.

On the boundedness singular integrals (with E. Fabes and M. Mitrea), Pacific Journal of Mathematics **189** no. 1 (1999), 21–29.

Spectral radius properties for layer potentials associated with the elastostatics and hydrostatics equations in nonsmooth domains, Journal of Fourier Analysis and Applications **5** no. 4 (1999), 385–408.

On the spectra of elastostatics and hydrostatics layer potentials on curvilinear polygons, Journal of Fourier Analysis and Applications **8** no. 5 (2002), 443–487.

On the Besov regularity of conformal maps and layer potentials on nonsmooth domains (with D. Mitrea), Journal of Functional Analysis, to appear.

Michael D. Morley

Professor Emeritus of Mathematics

Professor Morley's primary interest and contribution to the department lies in his devotion to the students. His skill, wisdom, commitment and sensitivity in advising is very well known throughout the Arts College. Comments about Michael Morley speak to his devotion: "[Mike Morley] is exactly the sort of advisor that Cornell needs..."; "...has a creative and total commitment to taking care of students..."; "...has been available to everyone's advisees who wander in unhappy." These comments speak eloquently of Prof. Michael D. Morley.

Professor Morley's primary research interests lie in the areas of advanced mathematical logic and model theory.

Camil Muscalu

Assistant Professor of Mathematics

My research interests include topics from classical analysis and partial differential equations. In recent years I have been studying boundedness properties of certain multilinear singular integrals and their Carleson maximal analogs.

Selected Publications

A joint norm control Nehari type theorem for N-tuples of Hardy spaces, J. Geom. Anal. **4** (1999), 683–692.

On the Harnack principle for strongly elliptic systems with non-smooth coefficients, Comm. Pure Appl. Math. **52** (1999), 1213–1230.

Multi-linear operators given by singular multipliers (with T. Tao and C. Thiele), J. Amer. Math. Soc. **15** (2002), 469–496.

Uniform estimates on multi-linear operators with modulation symmetry (with T. Tao and C. Thiele), J. D'Analyse Math. **88** (2002), 255–309.

A discrete model for the bi-Carleson operator (with T. Tao and C. Thiele), GAFA **12** (2002), 1324–1364.

Anil Nerode

Goldwin Smith Professor of Mathematics

My principal research at present is in hybrid systems. This is both the logic of hybrid systems (program specification and verification) and extracting digital control programs for hybrid systems. The former is developed in modal logics, the latter using the relaxed calculus of variations on manifolds and the apparatus of connections as controls. I also continue work on model theory and recursive model theory of nonstandard logics, foundations of logic programming, and multiple agent hybrid systems. The latest round of publications is below. A full bibliography is on the website www.math.cornell.edu/~anil/.

Selected Publications

Foreword to: Principles of Modeling and Asynchronous Distributed Simulation of Complex Systems by S. Ghosh, IEEE Press, 2000.

Automata Theory and Its Applications (with B. Khoussainov), Birkhauser, 2000, 480 pp., in press.

Normal forms and Syntactic completeness proofs for functional independencies (with M. Ganesh, J. Srivastava, D. Wijesekera), J. Theoretical Computer Science, to appear.

Constructive Logics and Lambda Calculi (with G. Odifreddi), 500 pp., book in preparation.

Agent Control, Enterprise Models and Supply Chain Systems (with W. Kohn), book in preparation.

Michael Nussbaum

Professor of Mathematics

My research program focuses on developing a better theoretical understanding of the asymptotic theory of statistical experiments, in connection with statistical smoothing and curve estimation and nonparametric inference for stochastic processes. Current topics include Gaussian and Poisson approximation of nonparametric experiments in the Le Cam sense, constructive realization of equivalence, asymptotic risk bounds for density estimation and nonparametric regression, nonparametric models for point processes, diffusion processes and autoregression, functional limit theorems for empirical processes, statistical treatment of inverse and ill-posed problems.

Selected Publications

Asymptotic equivalence of density estimation and Gaussian white noise, Ann. Stat. **24** (1996), 2399–2430.

Asymptotic equivalence for nonparametric generalized linear models (with I. Grama), Probability Theory and Related Fields **111** (1998), 167–214.

Diffusion limits for nonparametric autoregression (with G. Milstein), Probability Theory and Related Fields **112** (1998), 167–214.

The asymptotic minimax constant for sup-norm loss in nonparametric density estimation (with A. Korostelev), Bernoulli **5** (6) (1999), 1099–1118.

Minimax risk: Pinsker bound; in Encyclopedia of Statistical Sciences, Vol. 3 (S. Kotz, ed.), John Wiley, New York, 1999, pp. 451–460.

Kasso Okoudjou

H. C. Wang Assistant Professor of Mathematics

My research interests lie in harmonic analysis, specifically in time-frequency analysis and wavelet theory. My work to date has focused on studying finer properties of functions, e.g., time-frequency concentration, smoothness and decay using the theory of frames, in particular Gabor and wavelet frames. I am also interested in studying (multilinear) pseudodifferential operators using mainly a time-frequency approach.

Recently I have been working on analysis on pcf self-similar fractals. More precisely, I am interested in extending some "classical" results of analysis on

Euclidean spaces to this fractal setting using the analytic tools defined by Jun Kigami on pcf fractals.

Selected Publications

Gabor analysis in weighted amalgam spaces (with K. Grochenig and C. Heil), Sampling Theory in Signal and Image Processing **1** no. 3 (2002), 225–260.

Embeddings of some classical Banach spaces into modulation spaces, Proceedings of the American Mathematical Society **132** no. 6 (2004), 1639–1647.

Bilinear pseudodifferential operators on modulation spaces (with A. Benyi), Journal of Fourier Analysis and Applications (to appear).

Modulation spaces and a class of bounded multilinear pseudodifferential operators (with A. Benyi, K. Grochenig and C. Heil), submitted.

Weak uncertainty principles on fractals (with R. S. Strichartz), 2004 preprint.

Alessandra Pantano

H. C. Wang Assistant Professor of Mathematics

I am interested in the study of the non-unitarity of a (spherical) principal series of a real group. When the group is split, the signature of a Hermitian form on the isotypic of a “petite” K-type can be computed by means of Weyl group calculations. The result is a non-unitarity test for a spherical principal series for split groups, which is especially effective if a lot of “petite” K-types are known. My research focuses on the construction of petite K-types.

Lawrence E. Payne

Professor Emeritus of Mathematics

My research interests lie in several areas of partial differential equations: isoperimetric inequalities, ill-posed and non-standard problems, growth decay and/or blowup of solutions, and applications to various problems in solid and fluid mechanics.

Selected Publications

Pointwise and L_2 bounds in some nonstandard problems for the heat equation (with P. W. Schaefer) JMAA **284** (2003), 283–293.

On a nonstandard problem for heat conduction in a cylinder (with K. A. Ames and P. W. Schaefer) Appl. Anal. (2004) 125–133.

Energy and pointwise bounds in some non-standard parabolic problems (with K. A. Ames and P. W. Schaefer), Proc. Roy. Soc. Edinburgh **134** (2004), 1–9.

Spatial decay estimates in the channel flow of an incompressible viscous fluid (with C. H. Lin) Math. Models Meth. in Appl. Sci. (to appear).

Improved spatial decay bounds in generalized heat conduction (with J. C. Song), ZAMP (to appear).

Irena Peeva

Associate Professor of Mathematics

My research is broad and at the interface between the fields of commutative algebra, algebraic geometry, and combinatorics. I have worked on problems involving free resolutions, toric varieties, Hilbert schemes, complete intersections, subspace arrangements, monomial resolutions, Gröbner basis, Koszul algebras, shellings, and Castelnuovo-Mumford regularity.

Some of my research interests are focused on the structure of free resolutions and their applications. I study resolutions over polynomial rings and their quotients. In essence constructing a resolution over a ring R consists of repeatedly solving systems of R-linear equations. From another point of view, resolutions provide a homological method for describing the structure of modules (the idea to associate a resolution to a module was introduced in Hilbert’s famous 1890, 1893-papers).

Selected Publications

Complete intersection dimension (with L. Avramov and V. Gasharov), Publications Mathematiques IHES **86** (1997), 67–114.

Generic lattice ideals (with B. Sturmfels), J. American Mathematical Society **11** (1998), 363–373.

Deformations of codimension 2 toric varieties (with V. Gasharov), Compositio Mathematica **123** (2000), 225–241.

Finite regularity and Koszul algebras (with L. Avramov), American J. Math. **123** (2001), 275–281.

Toric Hilbert schemes (with M. Stillman), Duke Math. J. **111** (2002), 419–449.

Rodrigo Perez

H. C. Wang Assistant Professor of Mathematics

I am interested in combinatorial aspects of complex dynamics and their relationship with other areas; for instance, number theory and the theory of partitions, dynamics of polynomial automorphisms in $\mathbf{C}^2$ and geometric group theory.

The concept of "fractal group" has recently opened a vast new area of research by bringing algebraic methods to bear on the geometry of fractal sets. The iterated monodromy group $\mathrm{IMG}(f)$ of a rational map $f:\overline{\mathbf{C}}\to\overline{\mathbf{C}}$ with postcritically finite orbits is a finitely generated, infinitely presented group that seems to encode a lot of information about the structure of the corresponding Julia set. In joint work with Kai-Uwe Bux, we have established that $\mathrm{IMG}(z^2+i)$ is a group of subexponential growth. Currently, we are extending this proof to iterated monodromy groups of more general rational maps. We are also computing invariants of $\mathrm{IMG}(z^2+i)$ to better understand its fine structure. These include L-presentations, the spectrum of the Laplace operator on the Cayley graph and the associated Ihara zeta function.

As usual, the transfer of ideas between different areas brings the promise of new results. I expect to bring back techniques from geometric group theory into complex dynamics to study in detail the geometry of postcritically finite Julia sets.

Selected Publications

A new partition identity coming from complex dynamics (with G. E. Andrews), submitted.

Quadratic polynomials and combinatorics of the principal nest, submitted.

Geometry of Q-recurrent maps, submitted.

On the growth of iterated monodromy groups (with K.-U. Bux), in preparation.

A count of renormalizations in Multibrot sets (with A. Bridy), in preparation.

Philip Protter

Professor of Operations Research and Industrial Engineering

Recent interests include numerical methods for solving stochastic differential equations, filtration expansions and shrinkage, liquidity risk in finance theory, and credit risk in finance theory. All of these topics are related to stochastic calculus and stochastic differential equations, although they bring in techniques from weak convergence, Markov processes, Monte Carlo methods, data analysis, spline estimations, and the Malliavin calculus.

Selected Publications

Stochastic Integration and Differential Equations, Second Edition, Springer-Verlag, 2004.

Liquidity risk and arbitrage pricing theory (with Robert Jarrow and Umut Cetin), Finance and Stochastics (to appear).

Modeling credit risk with partial information (with Robet Jarrow and Umut Cetin), Annals of Probability (to appear).

The approximate Euler method for Levy driven stochastic differential equations (with Jean Jacod, Thomas Kurtz, and Sylvie Meleard), Annales of the Institut Henri Poincaré, special issue dedicated to the memory of P.A. Meyer (to appear).

A short history of stochastic integration and mathematical finance: the early years, 1880–1970 (with Robert Jarrow), The Herman Rubin Festschrift (IMS, to appear).

Ravi Ramakrishna

Associate Professor of Mathematics

My research is in Galois theory. This is the branch of mathematics concerned with symmetries of solutions of equations. There is an object that encodes all symmetries of solutions to all equations, the absolute Galois group of the rational numbers. I study this object and its relations with number theory. The study of these symmetries has gained an increasingly important role in number theory in recent years. In particular, Galois theory played an important role in the solution of Fermat's Last Theorem.

Selected Publications

Lifting Galois representations, Invent. Math. **138** no. 3 (1999), 537–562.

Infinitely ramified Galois representations, Ann. of Math. (2) **151** no. 2 (2000), 793–815.

Deforming Galois representations and the conjectures of Serre and Fontaine-Mazur, Ann. of Math. (2) **156** no. 1 (2002), 115–154.

Deformations of certain reducible Galois representations, J. Ramanujan Math. Soc. **17** no. 1 (2002), 51–63.

Finitenss of Selmer groups and deformation rings, Invent. Math. **154** (2003), 179–198.

Richard H. Rand

Professor of Theoretical and Applied Mechanics

My research involves using perturbation methods and bifurcation theory to obtain approximate solutions to differential equations arising from nonlinear dynamics problems in engineering and biology.

Current projects involve quasiperiodic forcing in Mathieu's equation, dynamics of coupled oscillators, and coexistence phenomenon in autoparametric excitation. Applications include NEMS (nano electrical mechanical systems), effects of biorhythms on retinal dynamics, cardiac arrhythmias, and ecology of plant communities. These projects are conducted jointly with graduate students and with experts in the respective application area.

Selected Publications

Lecture Notes on Nonlinear Vibrations, version 45, 2003.

Slow passage through resonance in Mathieu's equation (with L. Ng and M. O'Neil), Journal of Vibration and Control **9** (2003), 685–707.

Nonlinear dynamics of a system of coupled oscillators with essential stiffness nonlinearities (with A. F.Vakakis), International Journal of Nonlinear Mechanics **39** (2003), 1079–1091.

Dynamics of two van der Pol oscillators coupled via a bath (with E.Wirkus and H. Howland), International J. Solids and Structures **41** (2004), 2133–2143.

Perturbation solution for secondary bifurcation in the quadratically-damped Mathieu equation (with D. V. Ramani and W. L. Keith), International Journal of Nonlinear Mechanics **39** (2004), 491–502.

Etienne Rassart

H. C. Wang Assistant Professor of Mathematics

The interplay between combinatorics, the representation theory of complex semisimple Lie algebras, symplectic geometry and convex geometry has been a rich source of mathematical developments in recent years. Most of my recent work has been in using tools from all these areas to explore combinatorial invariants of the irreducible representations of the classical complex semisimple Lie algebras (types A, B, C, D), particularly the weight multiplicities and Clebsch-Gordan coeffcients. For type A, these appear in the combinatorial theory of symmetric functions in the form of the Kostka numbers and the Littlewood-Richardson coeffcients respectively. Efficiently computing the weight multiplicities and Clebsch-Gordan coefficients has been a long-standing problem. A variety of formulas and methods exist for them, some of which are efficient for certain ranges of the parameters, but no single approach seems to provide a fast way of computing these combinatorial invariants. The need for efficient algorithms is motivated by the fact that these numbers appear in quantum physical computations. My current research project ties into all these areas of mathematics, using tools from combinatorics, convex geometry and symplectic geometry to study the behavior of the Kostka numbers and Littlewood-Richardson coefficients.

Selected Publications

Signature quantization and representations of compact Lie groups (with Victor Guillemin), Proceedings of the National Academy of Sciences (to appear).

A polynomiality property for Littlewood-Richardson coefficients, Journal of Combinatorial Theory, Series A (to appear).

A vector partition function for the multiplicities of $sl_k(C)$ (with Sara Billey and Victor Guillemin), Journal of Algebra **278** no. 1 (2004), 251–293.

Path counting and random matrix theory (with Ioana Dumitriu), Electronic Journal of Combinatorics **10** no. 1 (2003), #R43.

Enumeration of symmetry classes of convex polyominoes in the square lattice (with Pierre Leroux and Ariane Robitaille), Adv. in Appl. Math. **21** no. 3 (1998), 343–380.

James Renegar

Professor of Operations Research and Industrial Engineering

I am currently devoting the majority of my research efforts to devising new algorithms for linear programming, i.e., for solving systems of linear inequalities. Unlike the situation for linear equations, surprisingly basic problems remain unresolved for linear inequalities. For example, it is unknown whether there exists an algorithm that can solve a general system of linear inequalities using a number of arithmetic operations that is bounded polynomially in the number of variables and the number of inequalities in the system. By contrast, elementary Gaussian elimination (i.e., high-school mathematics) solves a system of n linear equations in n unknowns in roughly n^3 operations.

I am also interested in devising algorithms for more general problems involving hyperbolic polynomials. (A hyperbolic polynomial p is a real multivariate polynomial for which there exists a vector v such that all univariate polynomials obtained by restricting p to lines in the direction v have only real roots.) These polynomials have played an especially important role in optimization in recent years.

Luke Rogers

H. C. Wang Assistant Professor of Mathematics

My research interests lie broadly in the area of harmonic analysis and geometric function theory, with a particular focus on Sobolev and quasiconformal mappings. In my graduate work I developed a degree-independent extension theorem for Sobolev spaces on locally uniform domains, a result that has its roots in earlier work of Stein and of Jones on this problem. The approach I found may also have application to related function spaces such as the Besov spaces.

At present I am thinking about various problems in the theory of Sobolev spaces on general metric spaces, especially some related to the work of Kigami and of Strichartz in developing an analysis on post-critically finite fractals. I am also interested in several questions about quasiconformal mappings, particularly those related to characterizing quasiconformal and Sobolev removable sets.

Laurent Saloff-Coste

Professor of Mathematics

I am an analyst who enjoys touching on other areas including probability theory and geometric group theory. I study different aspects of heat diffusion on manifolds from the point of view of both partial differential equations and stochastic processes. I am mainly interested in those properties that relate to the large-scale geometry of the underlying space. For instance, I have recently been trying to understand how heat diffusion is affected by the existence of more than one end on a manifold. Potential theory and functional analysis often provide the framework and tools to study these properties.

I also work on random walks on groups. A random walk is a Markov process (g_n) on a group G where g_n is obtained from g_{n-1} by left multiplication by a random element of a fixed finite generating set of G. For instance, card-shuffling methods can be modelized as random walks on the symmetric group S_{52}. In this example, G is finite but G can be infinite. What interests me most in this subject is relating the behavior of random walks to the algebraic structure of the group and to the geometry of its Cayley graphs.

Random walks on finite groups are special examples of finite Markov chains. In the past 10 years, I have worked on quantitative estimates for ergodic finite Markov chains. Some of the most interesting examples of such chains are connected to combinatorial problems that are not tractable by deterministic algorithms but for which a reasonable stochastic algorithm exists. These stochastic algorithms often involve a finite Markov chain as one of the main building blocks. In this context, obtaining quantitative estimates is essential.

Selected Publications

Central Gaussian semigroups of measures with continuous density (with A. Bendikov), Journal of Functional Analysis **186** (2001), 206–268.

On the relation between elliptic and parabolic Harnack inequalities (with W. Hebisch), Annales de l'Institut Fourier **51** (2001), 1437–1481.

Aspects of Sobolev Type Inequalities, London Mathematical Society Lecture Notes Series **289**, Cambridge University Press, 2002.

On random walks on wreath products (with C. Pittet), Annals of Probability **30** (2002), 948–977.

Hitting probabilities for Brownian motion on Riemannian manifolds (with A. Grigor'yan), Journal de Mathématiques Pures et Appliquées **81** (2002), 115–142.

Alfred H. Schatz

Professor of Mathematics

My field of research is numerical analysis. I have been principally involved in the analysis and construction of finite element methods for the approximate solution of partial differential equations. In particular I have been investigating both the local behavior of such matters and another phenomena associated with them called superconvergence. Many physical problems have solutions that are smooth in some places and are nonsmooth (having singularities) in others. In the numerical solution of these problems, the singular part of the solution is not only difficult to approximate but often lowers the quality of (pollutes) the approximation even where the solution is nice. I have been involved in understanding this phenomena and finding a way to improve the approximations.

Another facet of the research is to find properties of the computed approximate solutions which, when taken into account, can be used to produce better approximations than one has before. These are so called superconvergent approximations and their importance resides in the fact that the original approximations are usually difficult to obtain but usually the new approximates may be orders of magnitude better and easily computed from them.

Selected Publications

Superconvergence in finite element methods and meshes which are locally symmetric with respect to a point (with I. Sloan and L. Wahlbin), SIAM Journal of Numerical Analysis, to appear.

Interior maximum norm estimates for Ritz Galerkin methods, part II (with L. Wahlbin), Mathematics of Computation, to appear.

Some new error estimates for Ritz Galerkin methods with minimal regularity assumptions (with J. Wang), Mathematics of Computation, submitted.

Jason Schweinsberg

H. C. Wang Assistant Professor of Mathematics

I work in probability theory. Much of my research has focused on stochastic processes involving coalescence. One can think of coalescent processes as modeling a system of particles in which the particles start out separated and then merge into clusters as time goes forward. The probabilistic behavior of a coalescent process is determined by the rates at which clusters merge.

Coalescent processes can be used to model the genealogy of a population. In this application, the particles represent individuals in the current generation, and the merging of particles corresponds to the merging of ancestral lines going backward in time. The genealogy of many populations can be described by Kingman's coalescent, in which each pair of particles merges at rate one. I have studied primarily alternative models of coalescence. These include coalescents with multiple collisions, in which many particles can merge together at once, and coalescents with simultaneous multiple collisions, in which many such mergers can occur simultaneously. These coalescent processes can be used to model populations in which there can be very large families. In some recent joint work with Rick Durrett, we have shown that coalescents with simultaneous multiple collisions can also be used to model the genealogy of populations that are periodically affected by beneficial mutations. At the time of a beneficial mutation, multiple ancestral lines will coalesce nearly simultaneously if the new, favorable gene spreads to the entire population in a relatively short time.

I have also worked on some problems involving fragmentation processes, which can be viewed as coalescent processes run in reverse. In addition, I have done research related to reversible Markov chains. Some of this work has focused on the link between the recurrence and transience of reversible Markov chains and the notion of P-admissibility in statistical decision theory.

Selected Publications

A necessary and sufficient condition for the Lambda-coalescent to come down from infinity, Electron. Comm. Probab. **5** (2000), 1–11.

Coalescents with simultaneous multiple collisions, Electron. J. Probab. **5** (2000), 1–50.

Applications of the continuous-time ballot theorem to Brownian motion and related processes, Stochastic Process. Appl. **95** (2001), 151–176.

Coalescent processes obtained from supercritical Galton-Watson processes, Stochastic Process. Appl. **106** (2003), 107–139.

Random partitions approximating the coalescence of lineages during a selective sweep (with Richard Durrett), submitted.

Shankar Sen

Professor of Mathematics

Most of my research concerns invariants associated with representations of Galois groups of p-adic fields and algebraic number fields. These invariants, though of an arithmetic nature, are related to classical invariants arising in complex algebraic geometry; their study should shed light on geometric aspects of equations over number fields or p-adic fields. Recently, I have studied families of Galois representations depending analytically on p-adic parameters, and how the invariants for such families change with the parameters. Techniques from p-adic analytic function theory and functional analysis have proved useful in this connection.

Selected Publications

Lie algebras of Galois groups arising from Hodge-Tate modules, Annals of Math. (1973).

Integral representations associated with p-adic field extensions, Inventiones Math. (1988).

The analytic variation of p-adic Hodge structure, Annals of Math. (1988).

An infinite-dimensional Hodge-Tate theory, Bulletin Math. Soc. France (1992).

Galois cohomology and Galois representations, Inventiones Math. (1993).

Richard A. Shore

Professor of Mathematics

My major research interests have centered around analyzing the structures of relative complexity of computation of functions on the natural numbers. The primary measure of such complexity is given by Turing reducibility: f is easier to compute than g, if there is a (Turing) machine which can compute f if it is given access to the values of g. I have also worked with various other interesting measures of complexity that are defined by restricting the resources available primarily in terms of access to g. The general thrust of my work has been to show that these structures are as complicated as possible both algebraically and logically (in terms of the complexity of the decision problems for their theories). These results also allow one to differentiate among different notions of relative complexity in terms of the orderings they define.

Another major theme in my work has been the relationship between these notions of computational complexity and ones based on the difficulty of defining functions in arithmetic. Restricting the computational resources more directly in terms of time or space leads out of recursion theory and into complexity theory. Relaxing the restrictions by allowing various infinitary procedures leads instead into generalized recursion theory or set theory.

The methods developed in these investigations are also useful in determining the effective content of standard mathematical theorems (when can existence proofs be made effective) and the inherent difficulty of combinatorial theorems in proof theoretic terms. Recently, I have also been working on issues in effective model theory and algebra connected with the problem of how the computational properties of algebraic structures can vary with different (but always computable) presentations of the models.

Selected Publications

The degrees of unsolvability: the ordering of functions by relative computability; in Proceedings of the International Congress of Mathematicians (Warsaw) 1983, PWN-Polish Scientific Publishers, Warsaw 1984, Vol. 1, 337–346.

Logic for Applications (with A. Nerode), Texts and Monographs in Computer Science, Springer-Verlag, New York, 1993; second edition, Graduate Texts in Computer Science, Springer-Verlag, New York, 1997.

Definability in the recursively enumerable degrees (with A. Nies and T. Slaman), Bull. Symb. Logic **2** (1996), 392–404.

Defining the Turing jump (with T. Slaman), Math. Research Letters **6** (1999), 711–722.

Computable structures: presentations matter; in In the Scope of Logic, Methodology and the Philosophy of Science, Vol. 1, International Congress of LMPS, Cracow, August 1999 (P. Gardenfors, J. Wolenski and K. Kijania-Placek, eds.), Synthese Library **315**, Kluwer Academic Publishers, Dordrecht, 2002, pp. 81–95.

Reyer Sjamaar

Associate Professor of Mathematics

I study actions of Lie groups on symplectic manifolds. This is an area of differential geometry related to algebraic geometry and mathematical physics. Some of my recent work concerns moment polytopes and leads to improved versions of certain eigenvalue inequalities in matrix analysis.

Selected Publications

Holomorphic slices, symplectic reduction and multiplicities of representations, Ann. Math. (2) **141** (1995), 87–129.

Singular reduction and quantization (with E. Meinrenken), Topology **38** (1998), 699–762.

Moment maps and Riemannian symmetric pairs (with L. O'Shea), Math. Ann. **317** no. 3 (2000), 415–457.

Projections of coadjoint orbits, moment polytopes and the Hilbert-Mumford criterion (with A. Berenstein), J. Amer. Math. Soc. **13** no. 2 (2000), 433–466.

John Smillie

Professor of Mathematics

My area of interest is dynamical systems. I have done work on polygonal billiards and dynamics of flows on Teichmüller space; analysis of algorithms; and diffeomorphisms of surfaces. I am currently working on complex dynamics in two dimensions.

Selected Publications

Ergodicity of billiard flows and quadratic differentials (with S. Kerckhoff and H. Masur), Annals of Mathematics **124** (1986), 293–311.

Polynomial diffeomorphisms of C2 VII: hyperbolicity and external rays (with E. Bedford), Ann. Scient. Ec. Norm. Sup. **4** (32) (1999), 455–497.

The dynamics of billiard flows in rational polygons; in Encyclopedia of Mathematical Sciences, vol. 100 (edited by Yu. Sinai), Springer-Verlag, 1999.

Billiards on rational-angled triangles (with R. Kenyon), Comment. Math. Helv. **75** (2000), 65–108.

Polynomial diffeomorphisms of C2 VI: connectivity of J (with E. Bedford), Annals of Mathematics, to appear.

Brian Smith

VIGRE Assistant Professor of Mathematics

I am primarily interested in asymptotically flat Riemannian 3-manifolds of non-negative scalar curvature, which are used in general relativity to construct asymptotically flat, maximal initial data for the Einstein equations. More specifically, I am currently studying the construction of metrics on such manifolds using a parabolic partial differential equation.

Selected Publications

On the connectedness of the space of initial data for the Einstein equations (with G. Weinstein), Electron. Res. Announc. Amer. Math. Soc. **6** (2000), 52–63.

Quasiconvex foliations and asymptotically flat metrics of non-negative scalar curvature (with G. Weinstein), submitted.

Lawren Smithline

VIGRE Assistant Professor of Mathematics

I study p-adic modular forms. This area of number theory generalizes classical modular forms, which have starred in the resolution of long-standing problems such as Fermat's Last Theorem. The methods of p-adic analysis bridge algebraic geometry and classical analysis.

The combinatorial properties of the Atkin U operator have held special interest for me. Their structure makes computer experiments easy. The data suggest properties of the operator that result from the mode of generation, rather than the particular parameters derived from the modular forms. As described in recent seminars and a forthcoming paper, the U operator is an example of a compact operator with rational generating function.

Avery Solomon

Senior Lecturer of Mathematics

My position involves me in mathematics courses, mathematics education and outreach programs in several area schools. My position in the Cornell Teacher Education program in the Department of Education has involved me in supervising student teachers and co-teaching math/science methods courses.

In addition to these courses, I am the director of the Cornell/Schools Mathematics Resource Program (CSMRP). Through this program I organize and co-teach Saturday workshops and summer programs, consult with school districts, work with teachers directly to develop curriculum and programs, visit classrooms and occasionally teach classes in middle schools or high schools, and teach workshops in schools and at BOCES.

My current interests include the use of Sketchpad as an environment for learning geometry, the role of intuition in mathematical exploration, and integrating mathematics and philosophy in a humanist context. I am also the mathematics advisor to the Tibetan math/science for monks program, which is in the process of training 60 Tibetan monks in India to become future leaders in the dialogue between Western Science and Tibetan Buddhism.

Selected Publications

A fractal outline of a fractal course, AMTYS journal, 1989.

Proportions and levels of meaning in mathematics; in For the Learning of Mathematics, 1991.

What is a line?; in For the Learning of Mathematics, 1991.

Levels of knowledge, submitted for publication in Parabola, 1997.

Geometric patterns in nature, being prepared for publication.

Birgit E. Speh

Professor of Mathematics and Director of Undergraduate Studies

I am interested in the representation theory of reductive Lie groups, the cohomology of arithmetic groups and automorphic forms. In last few years, most of my work was related to geometric and topological properties of locally symmetric spaces. Some of my work also involves the Arthur Selberg Trace Formula.

Selected Publications

Pseudo-Eisenstein forms and cohomology of arithmetic groups (with J. Rohlfs), Manuscripta Mathematica **106** (2001), 505–518.

Absolute convergence of the spectral side of the Arthur trace formula for GL(n) (with W. Mueller), GAFA (to appear).

Pseudo-Eisenstein forms and cohomology of arithemtic groups II (with J. Rohlfs), Proceedings of Conference in honor of Ragunathan (to appear).

Construction of some modular symbols (with T. N. Venkataramana), Mathematische Zeitschrift, submitted.

Michael E. Stillman

Professor of Mathematics

My main areas of interest are computational algebra and algebraic geometry, commutative algebra, and algebraic geometry. My original interest in computational methods was their application to problems in algebraic geometry. Since then, my work has proceeded in several related directions. I have studied the complexity of the algorithms (mainly Gröbner bases). I have been developing algorithms for computing in commutative algebra and algebraic geometry (e.g. computing with line bundles, computing Hilbert functions, free resolutions, sheaf cohomology, computing with Hilbert schemes). In the last few years, Peeva and I have been interested in Hilbert schemes: classical ones, toric Hilbert schemes, and parameter spaces over the exterior algebra.

A major part of my research has been the development, with Dan Grayson at University of Illinois at Urbana, of Macaulay 2, a computer algebra system for research in commutative algebra and algebraic geometry. This system has a large following worldwide, a book written about it, and has been in active development for almost ten years.

Recently, I have become interested in the application of computational algebraic geometry to problems in statistics and molecular biology. The joint paper with Garcia and Sturmfels studies ideals and projective varieties that arise naturally when studying Bayesian networks on discrete random variables.

Selected Publications

A criterion for detecting m-regularity (with D. Bayer), Invent. Math. **87** (1987), 1–11.

Computing sheaf cohomology on toric varieties (with D. Eisenbud and M. Mustata), J. Symbolic Computation **29** (2000), 583–600.

Computations in Algebraic Geometry with Macaulay 2 (D. Eisenbud, D. Grayson, M. Stillman, B. Sturmfels, eds.), Springer, 2001.

Toric Hilbert schemes (with I. Peeva), Duke Math. J. **111** (2002), 419–449.

Algebraic geometry of Bayesian networks (with L. Garcia and B. Sturmfels), preprint (2003), available at http://front.math.ucdavis.edu/math.AG/0301255

Robert S. Strichartz

Professor of Mathematics

My research interests cover a wide range of topics in analysis, including harmonic analysis, partial differential equations, analysis on Lie groups and manifolds, integral geometry, wavelets and fractals. My early work using methods of harmonic analysis to obtain fundamental estimates for linear wave equations has played an important role in recent developments in the theory of nonlinear wave equations. My work on fractals began with the study of self-similar measures and their Fourier transforms. More recently I have been concentrating on a theory of differential equations on fractals created by Jun Kigami. Much of this work has been done in collaboration with undergraduate students through a summer Research Experiences for Undergraduates (REU) program at Cornell that I direct. I wrote an expository article — *Analysis on fractals*, Notices of the AMS **46** (1999), 1199–1208 — explaining the basic ideas in this subject area and the connections with other areas of mathematics.

Web sites created by students working with me may be found at www.mathlab.cornell.edu/reu/reu.html

Selected Publications

My web site, www.math.cornell.edu/~str, contains a complete list of my publications.

Steven H. Strogatz

Professor of Theoretical and Applied Mechanics

I have broad interests in applied mathematics. At the beginning of my career I was fascinated by mathematical biology and worked on a variety of problems, including the geometry of supercoiled DNA, the dynamics of the human sleep-wake cycle, the topology of three-dimensional chemical waves, and the collective behavior of biological oscillators, such as swarms of synchronously flashing fireflies.

In the 1990's, my work focused on nonlinear dynamics and chaos applied to physics, engineering, and biology. Several of these projects dealt with coupled oscillators, such as lasers, superconducting Josephson junctions, and crickets that chirp in unison. In each case, the research involved close collaborations with experimentalists.

I also love branching out into new areas, often with students taking the lead. In the past few years, this has led us into such topics as parametric resonance in microelectromechanical systems (MEMS); the nonlinear dynamics of HIV interacting with the immune system; and mathematical explorations of the small-world phenomenon in social networks (popularly known as "six degrees of separation"). Currently, we have been studying a wide variety of complex networks in both the natural and social sciences, using ideas from graph theory, statistical physics, and nonlinear dynamics.

Selected Publications

Sync: The Emerging Science of Spontaneous Order, Hyperion, 2003.

Exploring complex networks, Nature **410** (2001), 268–276.

Collective dynamics of 'small-world' networks (with D. J. Watts), Nature **393** (1998), 440–442.

Synchronization transitions in a disordered Josephson series array (with P. Colet and Wiesenfeld), Physical Review Letters **76** (1996), 404–407.

Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, Perseus Books, 1994.

Edward Swartz

Assistant Professor of Mathematics

My research centers on the interplay between matroids, geometry/topology and algebra. Matroids are combinatorial abstractions of linear independence. Their enumerative properties have applications in a variety of fields, including graph coloring and flows, linear coding, arrangements of hyperplanes, and problems in reliability theory. My interest in matroids originally started with the discovery of a close connection between matroids and quotients of spheres by elementary abelian p-groups. More recently, I have used face rings to establish a matroid analog of the g-theorem for simplicial polytopes. I have also established a universal representation theorem for all matroids as arrangements of homotopy spheres.

Selected Publications

Matroids and quotients of spheres, Mathematische Zeitschrift **241** (2002), 247–269.

Topological representations of matroids, Journal of the Amer. Math. Soc. **16** (2003), 427–442.

g-elements of matroid complexes, J. Comb. Theory Ser. B, to appear.

Lower bounds for h-vectors of $k - CM$, independence and broken circuit complexes, submitted.

Moss E. Sweedler

Professor Emeritus of Mathematics

First I worked in the area of Hopf algebras and wrote *Hopf Algebras*, which came to be the standard reference book on the subject. H. Allen and I used Hopf algebras to prove a 25-year-old conjecture of Jacobson. Over the ensuing years until about the mid eighties, I worked and published in the areas of commutative algebra and algebraic geometry, real-algebraic geometry, homological algebra, algebraic groups, purely inseparable field extensions and general positive characteristic phenomena, simple algebras and generalizations of the Brauer group, and differential algebra. Since the mid eighties I have primarily worked in the area of computer algebra, especially computational commutative algebra. This has produced both theoretical and applied results with applications beyond mathematics, such as to error control codes and resulted in my position as Director of the Army Center of Excellence for computer algebra.

Selected Publications

Groups of simple algebras, Institut des Hautes Etudes Scientifiques **44** (1975), 79–189.

A new invariant for the complex numbers over the real numbers (with D. Haile and R. Larson), American Journal of Mathematics **105** (1983), 689–814.

Gröbner bases for linear recursion relations on m-D arrays and applications to decoding (with I. Rubio and C. Heegard), Proc. IEEE Int'l Symp. on Information Theory, June 29–July 4, 1997, Ulm, Germany.

Remarks on automatic algorithm stabilization (with K. Shirayanagi), invited contribution to (fourth) IMACS Conf. on Appl. of Computer Algebra (1998).

Ideal and subalgebra coefficients (with L. Robbiano), Proceedings of the AMS (1998), to appear.

Maria S. Terrell

Senior Lecturer of Mathematics and Director of Teaching Assistant Programs

My recent interests in geometry have included tensegrities and the history of geometrical optics and linear perspective. I am collaborating with a group of faculty and graduate students in an effort to improve undergraduate mathematics instruction through a project we call GoodQuestions. The project is developing materials to help instructors engage students in meaningful discussions about key concepts in calculus. At a recent MER (Mathematicians in Education Reform) workshop I presented a paper about my recent experience in the project. (The GoodQuestions web site is located at www.math.cornell.edu/~goodquestions/.)

Selected Publications

Kaleidoscopes and mechanisms (with R. Connelly and B. Hendrickson), Colloqui Mathematica Societatis Janos Boyai **63** (1991).

Behind the scenes of a random dot stereogram (with R. Terrell), American Mathematical Monthly **101** no. 8 (1994).

Globally rigid symmetric tensegrities (with R. Connelly), Structural Topology **21** (1995).
Asking good questions in the mathematics classroom, paper presented at AMS-MER Workshop on Excellence in Undergraduate Mathematics: Mathematics for Teachers and Mathematics for Teaching, Ithaca College, March 13–16, 2003.

Robert E. Terrell

Senior Lecturer of Mathematics

Most of my creative work has been in writing educational mathematics software. I have interactive ODE solvers, PDE solvers, IFS makers, a linear algebra program, and various other things available on my web page. These are directed primarily to undergraduates, and the purpose of them is to let the student learn by exploring.

Selected Publications

Behind the scenes of a random dot stereogram (with M. Terrell), Amer. Math. Monthly **101** no. 8 (1994), 715–724.

William Thurston

Professor of Mathematics

Bill Thurston is a topologist, though his work impinges on many other areas of mathematics. He has discovered unexpected links between topology, hyperbolic geometry, and complex analysis.

Highlights of his career include his classification of foliations of codimension greater than one, his classification of surface automorphisms, his hyperbolization theorem in three-dimensional topology, and the theories of automatic groups and confoliations. Thurston has also made fundamental contributions to the theory of symplectic and contact manifolds, dynamics of surface diffeomorphisms, and the combinatorics of rational maps.

His current research includes random 3-manifolds and relations of knot theory to computational complexity. His main interest remains his geometrization conjecture, a far-reaching proposed generalization of his hyperpolization theorem.

Selected Publications

Three-dimensional manifolds, Kleinian groups and hyperbolic geometry, Bull. Amer. Math. Soc. (N.S.) **6** (1982), 357–381.
Hyperbolic structures on 3-manifolds, I. Deformation of acylindrical manifolds, Ann. of Math. **124** (1986), 203–246.
Word Processing in Groups (with D. B. A. Epstein, J. W. Cannon, D. F. Holt, S. V. F. Levy, and M. S. Paterson), Jones and Bartlet Publishers, Boston, MA, 1992.
Three-Dimensional Geometry and Topology, Princeton Mathematical Series **35**, Princeton University Press, Princeton, NJ, 1997.
Confoliations (with Y. Eliashberg), AMS, Providence, RI, 1998.

Alexander Vladimirsky

Assistant Professor of Mathematics

My research is mostly focused on building fast methods for problems in which the direction of information flow can be used to speed up the computations.

For example, numerical schemes for non-linear static PDEs often require solving coupled systems of non-linear discretized equations. For the first-order PDEs, partial knowledge of characteristic directions can be used to decouple those systems: solving the discretized equations one at a time is much more efficient. My thesis was devoted to construction of Ordered Upwind Methods (OUMs) for the PDEs arising in the anisotropic exit-time optimal trajectory problems. These methods were later extended to a wider class of problems in anisotropic (and hybrid) control and in front propagation.

My current work (joint with John Guckenheimer) concerns fast methods for approximating invariant manifolds of vector fields. This problem is numerically challenging not only because of the complicated manifold-geometry but also because of the anisotropic behavior of the vector field on that manifold. In our approach, a (co-dimension one) invariant manifold is locally modeled as a graph of some function satisfying a particular quasi-linear PDE, which can be quickly solved using yet another version of OUMs. A recent extension allows treating manifolds of higher co-dimension by (locally) solving a system of quasi-linear PDEs.

Selected Publications

Fast methods for the Eikonal and related Hamilton-Jacobi equations on unstructured meshes (with J. A. Sethian), Proc. Natl. Acad. Sci. USA **97** no. 11 (2000), 5699–5703.
Ordered upwind methods for static Hamilton-Jacobi equations (with J. A. Sethian), Proc. Natl. Acad. Sci. USA **98** no. 20 (2001), 11069–11074.

Ordered upwind methods for static Hamilton-Jacobi equations: theory & applications (with J. A. Sethian), SIAM Journal on Numerical Analysis **41** no. 1 (2003), 325–363.

A fast method for approximating invariant manifolds, (with J. Guckenheimer), SIAM J. on Applied Dynamical Systems (to appear).

Static PDEs for time-dependent control problems, submitted.

Karen Vogtmann

Professor of Mathematics

A fundamental technique for studying a group G is to view G as a group of automorphisms of a geometric object X. Geometric and topological properties of X can then be used to study algebraic properties of G. Beautiful classical examples of this are the theory of arithmetic and S-arithmetic groups acting on homogeneous spaces and buildings, including work of Borel and Serre on cohomological properties of these classes of groups, and the theory of groups of surface homeomorphisms acting on the Teichmüller space of the surface. I am interested in developing geometric theories for other classes of groups. In particular, I have worked with orthogonal and symplectic groups, SL(2) of rings of imaginary quadratic integers, groups of automorphisms of free groups, and mapping class groups of surfaces. My main focus in recent years has been on the group of outer automorphisms of a free group, where the appropriate geometric object is called Outer space. This space turns out to have surprising connections with certain infinite-dimensional Lie algebras (discovered by Kontsevich) and also with the study of phylogenetic trees in biology.

Selected Publications

Moduli of graphs and automorphisms of free groups (with M. Culler), Inventionnes **84** (1986), 91–119.

Cerf theory for graphs (with A. Hatcher), J. London Math. Soc. **58** part 3 (1998), 633–655.

The symmetries of Outer space (with M. Bridson), Duke Math Journal **106** no. 2 (2001), 391–409.

Geometry of the space of phylogenetic trees (with L. J. Billera and S. Holmes), Advances in Applied Math **27** (2001), 733–767.

Infinitesimal operations on complexes of graphs (with J. Conant), Math. Ann. **327** (2003), 545–573.

Lars B. Wahlbin

Professor of Mathematics

At present one can compute "solutions" to very tough nonlinear, singular problems on, say, a supercomputer. Most often, numerical analysis does not furnish theorems that cover a practical situation, but it provides insight into the behavior of the relevant numerical method on carefully chosen model problems with, at best, some of the most pertinent difficulties of the real problem present.

My work in numerical analysis is aimed at gaining a fundamental understanding of numerical methods. Such insight is also necessary for constructing better algorithms. My particular interest is in methods for partial differential equations, and lately I have been studying the precise and detailed behavior of the finite-element methods in a variety of problems; the most interesting ones contain singularities of various degrees of nastiness.

Selected Publications

Local behavior in finite element methods; in Handbook of Numerical Analysis (P. G. Ciarlet and J. L. Lions, eds.), vol. II (part 1), North Holland, 1991, pp. 353–522.

Superconvergence in Galerkin Finite Element Methods, Springer Lecture Notes in Mathematics **1605**, Springer-Verlag New York, 1995.

James E. West

Professor of Mathematics

My research has focused on the topology and symmetries of manifolds of finite and infinite dimensions, and on the related topics of polyhedra, absolute neighborhood retracts, function spaces and spaces of sets.

An example of the interplay between these theories is that manifolds modeled on the Hilbert cube appear naturally in several ways as limits of stabilization processes for finite-dimensional objects, and, unlike standard function space stabilization, retain more of their important properties, e.g. simple homotopy type. Study of the Hilbert cube manifolds has produced several of the initial breakthroughs in introducing control into the homeomorphism theory of finite-dimensional manifolds. This in turn, has been useful in analyzing the failure of the classical matrix algebra to describe equivariant homeomorphisms and homotopy types of manifolds with locally linearizable transformation groups, which in turn has led to new results on the topological classification of linear representations of finite groups. I have been involved in these studies.

Selected Publications

Mapping Hilbert cube manifolds to ANR's, Ann. Math. **106** (1977), 1–18.

Equivariant h-cobordisms and finiteness obstructions (with M. Steinberger), Bull. AMS (NS) **12** (1985), 217–220.

Nonlinear similarity begins in dimension 6 (with S. Cappell, J. Shaneson and M. Steinberger), Amer. J. Math. **111** (1989), 717–752.

Fibrations and Bundles with Hilbert Cube Manifold Fibers (with H. Torunczyk), Memoirs of the AMS **406**, 1989, iv + 75 pp.

Compact group actions that raise dimension to infinity (with A. N. Dranishnikov), Topology and its Applications **80** (1997), 101–114.

Kevin Wortman

H. C. Wang Assistant Professor of Mathematics

I study the large-scale geometry of discrete subgroups of semisimple Lie groups, and more generally, groups that act on nonpositively curved spaces. Most of my research to this point has focused on quasi-isometries and finiteness properties.

Selected Publications

Quasi-isometric rigidity of higher rank S-arithmetic lattices, preprint (Jan. 2004).

Quasiflats with holes in reductive groups, preprint (Jan. 2004).

Dan Zaffran

H. C. Wang Assistant Professor of Mathematics

Complex manifolds and holomorphic maps are the basic objects of study of “complex differential topology” (a close relative to “complex algebraic geometry”). Within this area, I'm especially interested in surfaces (i.e., compact complex manifolds of complex dimension two), Stein manifolds (see below), complex dynamical systems, singularities and foliations.

More details:

∞ The Kodaira-Enriques classification of surfaces is incomplete. An important aspect of this incompleteness concerns the surfaces “of class VII,” which are exactly the surfaces with first Betti number equal to one. Many such surfaces are known, but the existence of other examples is still an open problem. It is a remarkable (and recently discovered) fact that each Hénon mapping of $\mathbf{C}^2$ ($=\mathbf{C}\times\mathbf{C}$, where $\mathbf{C}$ is the field of complex numbers) is strongly related to a (uniquely determined) surface of class VII.

∞ Compared with the smooth category, the holomorphic category features several striking differences. For example, a compact complex manifold of positive dimension is never embeddable in $\mathbf{C}^n$. Stein manifolds are precisely those that admit an embedding in some $\mathbf{C}^n$. Being in some sense similar to smooth manifolds, they have attracted special attention. I'm working on the problem raised by J.-P. Serre of understanding the Steinness of any given fiber bundle with Stein fiber and Stein basis.

Selected Publications

Serre problem and Inoue-Hirzebruch surfaces, Math. Annalen **319** (2001).

Une caractérisation des surfaces d'Inoue-Hirzebruch (A characterization of Inoue-Hirzebruch surfaces) (with K. Oeljeklaus and M. Toma), Ann. Inst. Fourier **51**, fasc. 5 (2001).

A complete answer to the Serre problem with a bounded Reinhardt domain as fiber (with K. Oeljeklaus), in preparation.