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Courant Institute *of* Mathematical Sciences

Raghu Varadhan Awarded 2007 Abel Prize

Raghu Varadhan, Frank J. Gould Professor of Mathematics, was named the 2007 winner of the Abel Prize for his " 'fundamental contributions to probability theory and in particular for creating a unified theory of large deviations'…[His work] provides a unifying and efficient method for clarifying a rich variety of phenomena arising in complex stochastic systems, in fields as diverse as quantum field theory, statistical physics, population dynamics, econometrics and finance, and traffic engineering. It has also greatly expanded our ability to use computers to simulate and analyze the occurrence of rare events. Over the last four decades, the theory of large deviations has become a cornerstone of modern probability, both pure and applied."

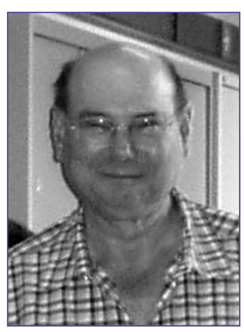
The Abel Prize was established by the government of Norway in 2002 following the model of the Nobel prizes to commemorate the 200th centenary of the birth of Niels Henrik Abel. The prize was given on May 22nd in Oslo, Norway by the Norwegian Academy of Science and Letters. This is particularly exciting for us, as it is the second time in five years that one of our faculty was named Abel Laureate. Peter Lax received the prize in 2005 for his "groundbreaking contributions to the theory and application of partial differential equations and to the computation of their solutions."

Courant Faculty Helmut Hofer and Amir Pnueli Named Silver Professors

In 1997, **Professor Helmut Hofer** came to the Courant Institute from the Swiss Federal Institute of Technology, Zurich, as a professor of Mathematics.

His major research interests center on symplectic geometry, dynamical systems, and partial differential equations. The field of symplectic geometry has been one of the most vibrant areas of research in pure mathematics for the last two decades. It is an outgrowth of classical Hamiltonian mechanics, which has application to many areas, including mathematical physics, dynamical systems, and low-dimensional topology. Its goal is to understand the global structure of solutions in phase space, with the potential for discovering and understanding new conserved quantities (invariants). Hofer has been a leader in the development of a comprehensive theory of symplectic invariants.

His pioneering contributions to contact and symplectic geometry were recognized by the award in 1999 of the biannual Ostrowski Prize. In addition, in 1998, he delivered an invited plenary address before the International Congress of Mathematicians in Beijing.



Professor Amir Pnueli joined the faculty of the Courant Institute in 1999. Previously, he had been on the faculties of the Weizmann Institute of Science and of Tel-Aviv University, where he founded and chaired the Department of Computer Science.

He is one of the pioneers of the field of verification. This field is concerned with proving the correctness of computer hardware and software. For many years this was regarded by many as a quixotic endeavor. However, by the mid-nineties, owing to the increasing difficulty of achieving acceptable reliability via testing alone, and owing to improved methods and faster computers, verification was increasingly recognized as an indispensable practical methodology.

The significance of this work has been amply recognized. Professor Pnueli received the ACM Turing Award in 1996 "…for his seminal work introducing temporal logic into computing science and for outstanding contributions to program and system verification"; he has also been elected to both the National Academy of Engineering (1999) and Academia Europaea (2006).

The Silver Professorships are awarded annually, funded by an endowment to the University from the late alumnus Julius Silver (who served as Chair of the Polaroid Corporation for many years).

Inside This Issue:

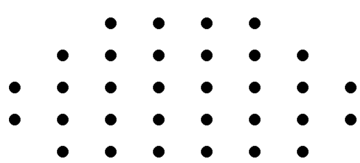
Spring / Summer 2007 Puzzle

By Dennis Shasha, Professor of Computer Science

During the 1930s, Frank Zamboni manufactured ice for boxcars carrying lettuce. When that business declined, he began building ice rinks in southern California. The climate there is tough on ice and he had to resurface frequently. During the hour this took, many of his customers would leave. So he invented—and then reinvented many times over the years—an ice resurfacer. These are still called Zambonis.

The basic problem is that when a Zamboni drives, everyone must just sit and wait. So, we want to make it accomplish its job as quickly as possible. The trouble is that the Zamboni doesn't have a very tight turning radius. For this reason, it must sometimes drive over spots it has already resurfaced. The question is how to minimize the resurfacing time.

We have abstracted the problem using the following slightly asymmetric shape: a 4-by-8 grid of points (nodes) with the corners cut off plus 4 more points on the top—32 points in all.



The distance between neighboring points is roughly the width of a Zamboni; your goal is to have the Zamboni drive over every node at least once. At every node the Zamboni can turn 45 degrees from the direction it is currently moving in. So, if the Zamboni has moved from node A to node B, it can move to node C if the angle formed by the rays AB and BC is 0 or 45 degrees. In other words, certain paths are acceptable and others are not.

Going from a node to a horizontally, vertically or diagonally adjacent node takes 30 seconds (the diagonal is sloped at 45 degrees). What is the fewest number of minutes you need to enter at the bottom (you can choose any bottommost node), drive over every node and then exit by some bottom node? Entering and exiting is from a driveway that is perpendicular to the bottom of the rink, so you can enter and exit at any angle you like. There is a solution that uses less than 20 minutes.

For the solution, email courant.alumni@nyu.edu
This problem is adapted from *The Puzzler's Elusion: A Tale of Fraud, Pursuit, and the Art of Logic* by Dennis Shasha, 2006.

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Yann LeCun: He's French, Loves Jazz, and Our Government Funds His Lab to Build Robots That Can See and Learn

By M.L. Ball

A Courant Institute Professor of Computer Science since 2003, Yann LeCun is at the forefront of today's cutting edge research in the field of autonomous robots.

From September 2003 to June 2004, Prof. LeCun spearheaded the DAVE project, a 'seedling' research project for the LAGR program (Learning Applied to Ground Robots), funded by DARPA (Defense Advanced Research Projects Agency, the research and development funding agency of the U.S. Department of Defense).

"In order to save soldiers' lives," Prof. LeCun explains, "Congress set up a mandate for the U.S. military to develop self-guided vehicles that could do a number of tasks (such as transporting supplies or mapping out an area) that now military personnel must do, often putting them in serious danger."

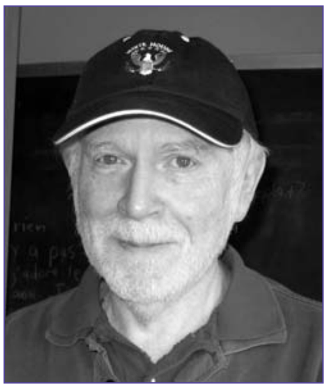
His challenge was to develop an autonomous robot that could 'see' with computer vision and negotiate obstacles. "The smartest computer can't do what a spider can do," Prof. LeCun acknowledges. "Certainly not what a mouse can. If we could ever invent a computer that was as smart as a rat or a squirrel, that would be fantastic. We know how to crunch numbers and write programs, but to program a computer to input an image from a camera and then determine if something is a tree or a person, that's really hard."

In the preliminary experiment, Prof. LeCun and his team built a small off-road robot nicknamed DAVE that used an end-to-end learning system to avoid obstacles solely from visual input. It had two cameras with analog video transmitters, and the video was transmitted to a remote computer that collected the data, ran the automatic driving system, and controlled the robot through radio control. They drove it under manual control avoiding obstacles, in various environments (parks and backyards), while recording the video and the human-provided steering angle. Using automatic machine learning methods, they then trained an artificial vision system to predict the steering angle of the human driver from a single pair of images from the cameras, and let the robot drive itself around.

"What we found," says Prof. LeCun, "was that it could actually avoid obstacles quite successfully, and drive itself around cluttered backyards without bumping into things." The success of the DAVE project helped convince DARPA in 2005 to launch the LAGR project (Learning Applied to Ground Robots). Prof. LeCun's team is one of only eight participants in this effort, which continues until December of this year. The project is more advanced and complex than the earlier DAVE project, and according to Prof. LeCun, is proving to be quite challenging.

He explains, "Until now, robot vision primarily used preprogrammed methods. What we are trying to do is build an artificial vision system that is somewhat inspired by our knowledge of animal vision, and that can learn by itself to distinguish obstacles from traversable areas."

Courant Professor Percy Deift Explains Some Recent Developments on Universality for Mathematical Systems



A full professor at the Courant Institute since 1988, **Percy Deift** has been a major influence in the development of techniques used to analyze a diverse range of mathematical and physical models.

A plenary speaker at the International Congress of Mathematicians in Madrid, Spain in August 2006, Prof. Deift generated great interest with his paper, "Universality for Mathematical and Physical Systems."

When recently asked to describe his presentation, Prof. Deift explained the following: all physical systems in equilibrium obey the laws of thermodynamics, the most familiar being the conservation of energy. Macroscopic objects, such as a table, obey the laws of thermodynamics, yet they are built out of microscopic atoms subject to their own laws of interaction. The juxtaposition of these two points of view—the macroscopic world of tangible objects and the microscopic world of atom—presents a fundamental challenge to scientists, namely, how does one derive the macroscopic laws of thermodynamics from the microscopic laws of atoms? As the laws of physics tell us, the same laws of thermodynamics should emerge at the macroscopic level no matter what the interaction of the atoms. In physics, this is an aspect of what is known as universality.

"Until recently," said Prof. Deift, "this kind of thinking was foreign to mathematicians who tend to think of their problems as unique and separate, i.e., two problems are the same only if one can establish absolute parallelisms between them. But in the last few years, a number of key mathematical examples have emerged which display universal behavior even though no rigorous parallelism has been established."

Following on the famous work of Eugene Wigner from the 1950s, what Prof. Deift and others have discovered is that the model for the universal behavior of these examples is given by the eigenvalues of a random matrix. To illustrate, he explains a method that bus drivers in Cuernavaca, Mexico devised for maximizing their profits and minimizing the waiting time for passengers. Without a municipal bus system, there was no standardized timetable; sometimes there were long waits between buses, and sometimes the buses would bunch up. If a driver arrived at a stop when another bus was loading up, he would have to move on to the next stop and thereby lose fares. Then the bus operators came up with an effective solution: they hired observers to stand along the route at various points and tell the drivers to speed up or slow down, depending on how long it had been since a bus had passed by. The result? Reliable bus service, happy passengers, and larger profits for the drivers.

Recently, two Czech physicists, Krbalek and Seba, visited Cuernavaca, came across this phenomenon, and decided to investigate it. They gathered data for a month and found, quite remarkably, that the spacings between buses behave statistically like the spacings between the eigenvalues of a random matrix.

Another example of universality described by Prof. Deift is one familiar to us all: how long does it take to board an airplane? Assuming there is one seat per row, all passengers can move quickly, and storing luggage takes one unit of time, then the boarding time (assuming the passengers board randomly), is again modeled by the eigenvalues of a random matrix.

The significance of these ideas, according to Prof. Deift, is that "they have led mathematicians to investigate universal behavior for a variety of mathematical systems. Now there's a viewpoint, a way, to evaluate the collective behavior of systems and show that it has a universal character."

Take a Step Back in Time

By Cathleen Synge Morawetz

Many of the older Courant graduates will remember Eleazer Bromberg. He died last year in Pennsylvania at the age of ninety-three. He was a student in the forties of Jim Stoker, finishing up in 1951. In 1953, at Richard Courant's request, he left Reeves Instrument Corporation to help and then direct the setting up of our first big computer, the Univac. He had been head of the Mechanics branch of the Office of Naval Research and no one knew better than Lazer, as he was known, the defining mechanisms of the bureaucracies of the government agencies that supported our fledgling institute. He was invaluable.

In 1957, he became the Administrative Manager of Courant and in 1959, the Assistant and later Associate Director, at the same time being first an associate and later a full professor in the institute. He acquired over those years as keen a sense for analyzing the inner workings of the administration as he had had of ONR. He passed a lot on to me. I used it as I moved through a string of similar positions: how to look at a budget, how to think objectively about new hires, real down to earth experience. He played a big role in trying to keep our budget in line as we acquired our new building. I especially remember that the University's central administration had "stuck" us with a million dollar debt because that was the piece of the costs that we had not succeeded in raising. We carried that for years and it was often a painful talking point in budget discussions.

In 1970, Lazer moved over to the central administration and was Vice-Chancellor for Academic Affairs and later Deputy Chancellor during the time that Sidney Borowitz was Chancellor. He later returned to his professorship but left for the Bureau of Standards (now NIST) to complete his career.

Lazer was married to Edith Weiss whom I remember from our Real Variable class in 1947 with our beloved Professor Flanders. They had three sons, Dan, Michael and Jeremy.

In addition to his administrative talent, Lazer brought several colleagues from Reeves. Among them were Jerry Berkowitz, who was Chair of Mathematics from 1964 to 1980, Ruth Shor, who for many years was the guardian angel of our graduate students, and Louis and Frances Bauer.

The Courant Institute recognizes with gratitude the following alumni, faculty, and friends who have made gifts for the current fiscal year to date.

Please note that fiscal year 2006-2007 ends August 31, 2007. Each additional gift made by that date is especially appreciated.

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And special thanks to our endowment-level donors:

Helen Kimmel, for establishing the Lilian and George Lyttle Professorship in Applied Mathematics in honor of her late parents; **Marshall and Marilyn Butler**, for establishing the Dr. Charles M. Newman Fellowship for graduate students in honor of the Institute's former Director; **Raghu Varadhan** and **Daniel Stroock** for re-establishing the Courant Lectures (please see article on last page); **Maurice Machover** (Ph.D. '63) for a pledge of an unrestricted bequest; **David Garbasz** for a gift in support of K-12 outreach; and **Charles** (M.S. '77) and **Merryl Zegar** for an unrestricted gift.

A permanent named fund may be established for a minimum gift of $50,000, payable in differing ways. For further information please contact the Courant Development Officer as indicated below.

 Please contact Courant Development Officer Mark Hansen at courant.alumni@nyu.edu or (212) 998-6775.

Faculty Honors and Awards

Henry McKean, Professor of Mathematics, has been awarded the **2007 AMS Leroy P. Steele Prize** for Lifetime Achievement. The prize citation honors him for "his rich and magnificent mathematical career" and recognizes his "profound influence on his own and succeeding generations of mathematicians."

Weiqing Ren, Assistant Professor of Mathematics, **Scott Sheffield**, Assistant Professor of Mathematics, and **Akshay Venkatesh**, Associate Professor of Mathematics, were named **Sloan Research Fellows** for 2007. These awards are intended to enhance the careers of the finest young faculty members in specified fields of science. Currently a total of 116 fellowships are awarded annually in seven fields: chemistry, computational and evolutionary molecular biology, computer science, economics, mathematics, neuroscience, and physics.

Undergraduate Research

Kristina Chodorow, a senior in the Computer Science Department, recently was selected for Honorable Mention in this year's CRA (Computing Research Association) Outstanding Undergraduate Awards. Her research, supervised by Silver Professor Margaret Wright, aimed at improving a popular direct search optimization method for problems in which the function being minimized is extremely expensive to compute. Kristina developed a new algorithm that makes better use of already-computed function values. In numerical tests so far, her method has been competetive with or more efficient than several widely used codes. Maragaret Wright comments that, "Kristina is an outstanding and impressive student in talent, intellectual accomplishment, and service to the community."

2007 Courant Institute Student Prizes Awarded April 13th. Congratulations to the following winners:

Henning Biermann Award – Ashish Rastogi
Sandra Bleistein Prize – Caroline Muller
Hollis Cooley Prize – Henry O. Jacobs
Janet Fabri Prize – Iuliana Ionita
Kurt O. Friedrichs Prize – Yoichiro Mori
Max Goldstein Prize – Morgan Silver
Harold Grad Memorial Prize – Alexey Kuptsov and Ashish Rastogi
Moses A. Greenfield Research Award – Alexander Hasha and Matthias Heymann
Wilhelm Magnus Memorial Prize – Ryan Walker
Bella Manel Prize – Tatiana Yarmola
Matthew Smosna Prize – Christopher Robert Fagiani and Michael Schidlowsky

The centennial of Wilhelm Magnus' birth was celebrated during this year's events. Harry Hochstadt gave personal remarks about Magnus during the prize ceremony, and Jutta Magnus Nemec and Alfred Magnus gave special and touching remembrances about their father during the reception which followed. The texts of these speeches may be viewed on the Courant Alumni webpage at http://www.cims.nyu.edu/alumni/ under "Recent Events".

NYU Women in Computing Group Visit the IBM T.J. Watson Research Center

Women in Computing (WinC), a student organization sponsored by the Computer Science Department of the Courant Institute at NYU, along with IBM, organized a student visit to the IBM Watson Research Center at Hawthorne on Friday, March 30th. The visit included talks by senior IBM executives and researchers and was attended by NYU students at the undergraduate, M.S., and Ph.D. levels.

The highlight of the event was a talk by Fran Allen who is an IBM Fellow Emerita, this year's Turing Award winner and the first woman to win this award. Fran Allen's talk, entitled "Compiling a Career", provided an overview of her inspiring career and her important contributions to the field of computer science. The NYU students were both moved and inspired by Fran Allen's talk.

IBM speakers were: Cathy Lasser (VP, Industry Solutions and Emerging Business), alumna and Courant Council member Susan Puglia (VP, Quality and Process Transformation Executive for Technical Career Paths Development and Technical Support), Brenda Dietrich (Director, Mathematical Sciences), Anshu Kak (Executive IT Architect), Mahesh Viswanathan (Lead Architect, Information on Demand).

During lunch, the students had an opportunity to meet with other CIMS alumni working at IBM including Michael Burke, Philippe Charles, Meng-chen Hsieh, Anca Ivan, Rodric Rabbah, Edith Schonberg, Alexander Totok, Aristotelis Tsirigos and to hear speakers Charles Lickel (VP, Software) and David Cohn (Director of Business Informatics).

WinC's mission is to support women interested in Computer Science and technology by providing an environment to encourage them and activities to inspire them. In addition to IBM, WinC collaborates with Google and Morgan Stanley to organize academic panels, technical workshops, a mentoring program, recruiting (full-time jobs) and internship events along with company visits. We send our thanks to Fran Allen and our alumni participants.

The 2007 Courant Lectures

The 2007 Courant Lectures, "Traces, Determinants, and Probability Theory" and "Quillen Metrics, the Hypoelliptic Laplacian: the role and the functional integral" were presented on March 23rd and 26th by Prof. Jean-Michel Bismut, Professor of Mathematics at University Paris XI (Orsay) and one of the world's leaders in index theory, probability, geometry, and stochastic control.

We are very pleased to announce that this venerable lecture series has been re-invigorated through extremely generous endowment gifts from Dan Stroock, in memory of Alan Stroock, who was a long time supporter of NYU both financially and through his many years of service on the board of trustees, and by the Gopal Varadhan Foundation, established in memory of Mr. Varadhan, an alumnus of New York University, WSUC class of 1990, who lost his life in the September 11, 2001 attacks on the World Trade Center.

The origin of the lectures dates back to Richard Courant's 70th birthday on January 8, 1958, when his friends established a fund to endow a series of Courant Lectures to be delivered every two years. Kurt Friedrichs, who was chosen to present the gift, stated, "One may think that one of the roles mathematics plays in other sciences is that of providing law and order, rational organization and logical consistency, but that would not correspond to Courant's ideas. In fact, within mathematics proper Courant has always fought against overemphasis of the rational, logical, legalistic aspects of this science and emphasized the inventive and constructive, esthetic and even playful on the one hand, and on the other hand those pertaining to reality. How mathematics can retain these qualities when it invades other sciences is an interesting and somewhat puzzling question. Here we hope our gift will help."

The first speaker, in 1959, was Eugene Wigner, one of the greatest mathematical physicists of the 20th century. His talk, "The Unreasonable Effectiveness of Mathematics in the Natural Sciences," became quite famous and was subsequently published in *Communications on Pure and Applied Mathematics.*

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