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Louis Nirenberg shares 2015 Abel Prize with John Nash

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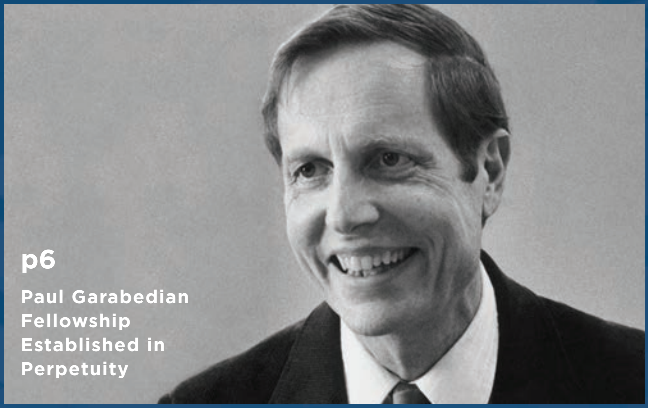
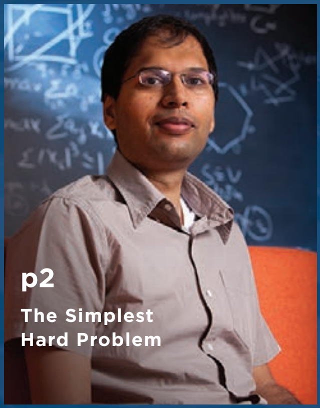




ALSO IN THIS ISSUE:

NYU COURANT INSTITUTE OF MATHEMATICAL SCIENCES

The Simplest Hard Problem: Subhash Khot on the Unique Games Conjecture

by April Bacon

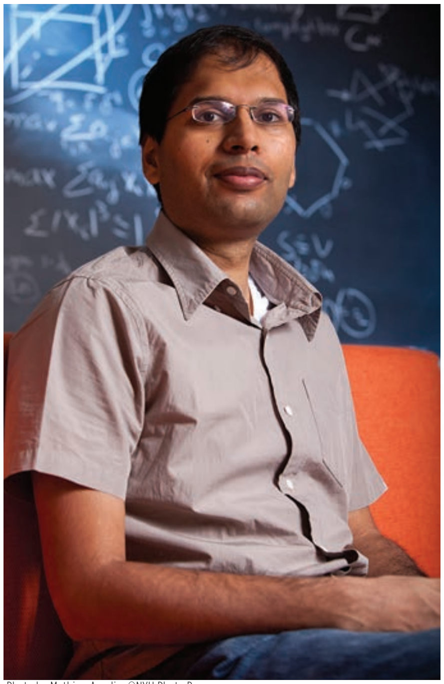


Photo by Mathieu Asselin. ©NYU Photo Bureau.

When he was seventeen, Subhash Khot touched a computer for the first time as a newly admitted undergraduate student at the Indian Institute of Technology, Bombay. He arrived at IIT with a mathematical foundation largely acquired through intensive self-study and the encouragement of one exceptional high school teacher and headmaster, V. G. Gogate. Just five years later, enrolled in the Ph.D. program at Princeton, Subhash wrote "On the power of unique 2-prover 1-round games," a paper proposing the Unique Games Conjecture (UGC), which established a new paradigm in complexity theory.

Now a Professor of Computer Science at NYU's Courant Institute for going on nine years, Subhash appreciates the Institute for its integrated mathematics and computer science departments, its distinguished faculty, and for how well his life is blended with his work. "It's a place where people enjoy doing what they are doing. It is kind of collaborative as opposed to being too competitive," he says.

In August 2014, Subhash was awarded the Rolf Nevanlinna Prize, one of the top honors given by the International Mathematical Union. Subhash received the prize, which is awarded only once every four years, not only for defining the UGC, but also for leading efforts to understand "its complexity and its pivotal role in the study of efficient approximation of optimization problems."

Long time friend and collaborator Assaf Naor (Princeton) traces Subhash's "pivotal role" back to his graduate student years at Princeton. It was there, under the mentorship of his Ph.D. advisor, Sanjeev Arora, and another mentor, Johan Håstad (Royal Institute of Technology in Stockholm), that Subhash quickly found one of the research agendas that would define the last decade and a half of his scientific career: showing that many computational problems are hard to approximate. The Unique Games Conjecture concerns one such specific problem, and the foundation on which Subhash built it came from a famous theorem in the 90s called the PCP (Probabilistic Checking of Proofs) Theorem, with which Arora and Håstad were both involved.

As a graduate student, Subhash "formulated various ways to strengthen the PCP theorem," says Assaf, and of the three approaches Subhash pursued, "two became major theorems." One of these was the "quasi-random PCP, which led to a very difficult and impressive work that involved showing that it's difficult to partition a graph efficiently … So this is one of the things that he did which was a success. But then, of course, came the Unique Games Conjecture … and he quickly realized how important this conjecture is."

"There is no reason why it wasn't proposed before," Subhash humbly offers. "Probably because, in some sense, one would need to be … I don't know what the word is … foolish enough? I was just a grad student who

The International Mathematical Union presented Subhash Khot with its Nevanlinna Prize on August 13, 2014 at the International Congress of Mathematicians conference in Seoul, Korea. Khot was awarded the Prize "for his prescient definition of the 'Unique Games' problem, and leading the effort to understand its complexity and its pivotal role in the study of efficient approximation of optimization problems; his work has led to breakthroughs in algorithmic design and approximation hardness, and to new exciting interactions between computational complexity, analysis and geometry."

was starting out. I had no fear that, 'Ah, if I propose the conjecture and if it gets quickly disproved and turns out to be obviously wrong, that would be a big embarrassment.' I was not afraid of any such thing."

So what is the Unique Games Conjecture? In mathematical terms, according to Subhash, "The problem is about solving a system of linear equations over a large field. The equations are linear and each equation depends on only two variables. So you have a bunch of variables and a bunch of equations of this kind and then the conjecture states that even if we are promised that there is a solution to this system of equations which satisfies 99% of the equations, it remains computationally difficult to find a solution which satisfies even 1% of the equations."

Using the UGC, "you can get very precise approximation thresholds for the performance of efficient algorithms for seemingly unrelated problems," says Assaf. That is, the UGC has proven to precisely illuminate the dividing line between approximability and inapproximability in a wide class of problems. "In a certain precise, technical sense, Unique Games seems to be the simplest really, really hard problem," says the IMU. This is because the UGC is hard enough to qualify as a hard problem, but has a simple enough structure to, as Subhash phrased it, "sit inside of other problems."

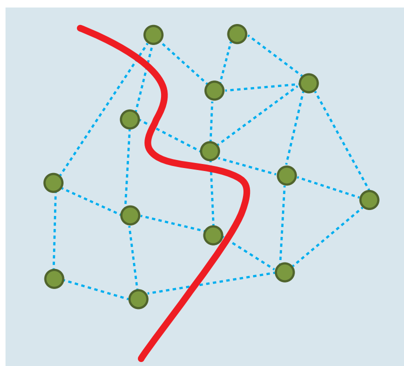
"Proposing the conjecture itself wasn't so much of a big deal," offers Subhash. "What followed in the next ten plus years with many developments, I think that was the main contribution, a joint effort by several researchers; this was unexpected of course." Over those ten plus years, the UGC inspired many new techniques and results which are valid whether or not the UGC is true. Through the efforts of Subhash and others, these unexpected benefits came about through approaching the conjecture in different ways—through reductions (i.e. reducing one problem to another), and through attempting to both prove and disprove the UGC.

Reductions from the conjecture are mathematically involved constructions in and of themselves and so, in order to make use of the conjecture, new tools were needed and therefore discovered in the areas of Fourier analysis, isoperimetric inequalities in geometry, and invariance principles in probability.

Trying to prove the UGC has also had unexpected benefits, "for example, trying to prove the conjecture actually resulted in solving an isoperimetric type problem in geometry called constructing foams," says Subhash. "You could take another approach and say, I instead want to disprove the UGC and this amounts to coming up with an algorithm for the Unique Games problem. The UGC states that the Unique Games problem is hard and you disprove the conjecture by in fact showing that the problem is easy … people attempted to come up with new algorithms and though they didn't succeed fully, there were some partial results which were already new algorithmic techniques."

After summing up the many aspects of the conjecture which Subhash himself has "championed and pushed forward," Assaf says: "And this is not all of his work! This is just some of it. There are many other things." For example, "Subhash was the first person who proved that it is very hard to solve a fundamental problem in cryptography called the Shortest Vector Problem in Lattices, and he proved that all kinds of problems in learning theory are intractable … [and] he proved a beautiful theorem just this fall on a problem called Monotonicity Testing."

Along with collaborator Dana Moshkovitz (M.I.T.), one major part of Subhash's current work is an approach they have proposed to prove the Unique Games Conjecture. "We are making what seems to be a slow and steady progress, but it will probably take a long time," says Subhash. In the meantime, as the IMU says, "The Unique Games Conjecture will be driving research in theoretical computer science for many years to come."



The graph partitioning problem seeks to partition a given graph into two roughly equal parts so as to minimize the number of edges cut. Khot's work gives evidence that this problem might be hard to approximate.

$$x1 - x7 = 11 \pmod{17}$$
$$x2 - x3 = 13 \pmod{17}$$
...
....
$$x7 - x9 = 15 \pmod{17}$$

Unique Game Problem

An instance of the Unique Games problem. The Unique Games Conjecture states that when the modulus (in this case 17) is large, it is hard to find a good assignment to such a system of linear equations.

Brittany Shields presents the 2014 Holiday Lecture

This past December, Brittany Shields presented 2014 Holiday Lecture on "The Courant Institute of Mathematical Sciences: A Historical Perspective, 1934-1972." Shields (who received her M.A. from NYU in 2008) recently earned her Ph.D. from the University of Pennsylvania (2015) with the dissertation, *A Mathematical Life: Richard Courant, New York University, and Scientific Diplomacy in Twentieth Century America*. The full Holiday Lecture video is now available online, along with past lectures, at http://video.cims.nyu.edu/media/HolidayLectures/

New Faculty Highlight: Tim Austin

by M.L. Ball


Tim Austin and graduate student Moumanti Podder.

Photo by Mathieu Asselin. ©NYU Photo Bureau.

Born in London and raised in Colchester, England, Courant Institute Associate Professor of Mathematics Tim Austin is an ergodic theorist. His research focuses primarily on analysis, probability, ergodic theory, metric geometry and geometric group theory.

From Cambridge to Microsoft, then to UCLA and Brown, and finally, to Courant

Even in his early teens, Tim Austin knew he wanted to study math. "I started to read popular science and popular math and got enthusiastic about it, and very quickly decided that's what I wanted to do," says the Courant Institute Associate Professor. "My family was not especially mathematical. My parents were actually both librarians, so it was quite a bookish household. They fully supported my interests, but neither of them was mathematically inclined at all."

After earning his undergraduate degree in pure mathematics from Cambridge University in 2005, Professor Austin found himself drawn to analysis. "I didn't have a particular subject in mind but I knew I wanted to do some kind of analysis, and there were not many people doing really crunchy hard analysis in Cambridge," Tim recalls. "When I asked my professors where the good analytic people were, they generally mentioned places in the U.S., particularly UCLA, because Terence Tao was there."

In short order, Tim gained admission to UCLA's graduate program and was invited by Terence Tao to be one of his students. "My original plan was to go to L.A. in mid-August, 2006, but one of the people I applied to work with in the U.S., Yuval Peres, was moving to Microsoft Research, and he offered me a month's position as a consulting researcher, learning about what they do and thinking about some problems," he explains. "So before I even showed up at grad school at UCLA, I spent July of that year in Redmond, Washington at the main Microsoft campus. I got to know quite a few of the people there—most importantly, Assaf Naor."

While still at UCLA, Tim was invited by Professor Naor (now at Princeton) to spend a month working with him at Courant, to gain some diversity and to be exposed to a bigger range of problems. "That initial month was my introduction to Courant," Tim says. "It turned into a long-term collaboration with Assaf, sparked my interest in coming here, and was a chance for me to learn more about what people are doing at Courant."

The Clay Institute Fellowship funds research for five years

Founded in 1998, the Clay Institute supports the international mathematical community by employing research fellows and scholars, and by bestowing research awards in recognition of extraordinary achievement. Once Professor Austin received his graduate degree from UCLA in 2010, Terence Tao recommended him for a Clay fellowship, and auspiciously, he was awarded it—the only one bestowed that year. "It's a 5-year stipend, which is very generous and very nice," Tim says. "What's also really great about it is that you can do your research in any 'approved' academic institution you want, or at a place like Microsoft. You then spend your time just thinking about math and talking with colleagues, trying to solve problems."

Tim just finished the five-year fellowship. The first two years were spent at Brown University, primarily because his fiancée, Kathy Smith, was doing a postdoc there. She was then offered a faculty fellowship at NYU, enabling the couple to move together to New York in 2012. Before coming to Courant full time, Tim conducted research for Clay during spring semesters, then taught a Courant course each fall, which he found to be a good balance. "Some people can just go away and do research for 40 hours a week and not do anything else and be very productive," Tim states. "I was actually starting to go a little bit crazy by the end of my time at Brown—a little too much time inside my own head—so teaching is a very good outlet for that."

Ergodic theory: a branch of dynamical systems

As an ergodic theorist, Tim's work is concerned with the study of the mathematical structures needed to describe a system in the real world that can exist in a range of different states, and that changes its state as time passes according to a fixed rule. As he describes it, "Ergodic theory studies the questions that concern long run averages, or other statistical properties of these systems. So I look at how the rate, or some other quantity that answers one of these questions, could be computed in terms of something else. I ask more 'pure' questions about sub-classifying the possible structure of systems within some large class, according to what kinds of behavior they exhibit—or even better, generating a smaller list which effectively captures all the possibilities."

"Let me say two things about examples of probability-preserving systems," said Tim. "Historically, the examples that gave rise to the modern theory are models of the solar system and of the motion of the particles of gas in a box. However, there are also simpler abstract examples that play an important role in the theory as objects of comparison. Two of the most important of these are a rigid rotation of the points around a circle, and the progression of a sequence of 'pure noise' random bits by one time-step."

A knack for solving problems but not knowing he's solved them

"I don't think I've ever had a moment where I have an idea and immediately know, 'This is the idea that will solve the problem,' Tim reveals. "Rather, what has happened several times is that I'm bumbling along trying this, trying that, and it doesn't work. Then something comes along and I think, 'Oh that's an interesting idea…I'm not quite sure what that does,' and I keep it in the back of my mind."

Then four weeks later, he says, as he is lying in bed or riding on the bus, he will suddenly realize that that was the very idea he needed. "I don't even remember having the idea," Tim says. "Only much later do I realize the problem was already solved and I just didn't notice it, which is very annoying actually, because probably during those four weeks, I tried a whole load of other things and got quite frustrated and didn't need to."

The Courant Institute: an interdisciplinary network of collaborators

Tim has been at the Courant Institute for two and a half years, and the collaborative atmosphere and easily approachable faculty have been a pleasure, he says. "Courant has supported me very generously. It also has this nice bent that people are not very rigidly classified by what kind of research they do. Everyone has their own specialties, but it's very natural to talk to people whose interests are perhaps quite far from your own, to try to find something in common or just chat for general interest," he says. "This forces you to examine whether what you're doing is interesting."

An additional benefit of Courant's tradition of interdisciplinary interaction, Tim adds, is the fact that "because you get to learn about more diverse things, it might help you decide on some new direction of research. You can tap into the knowledge of your colleagues regarding some problem or dead end that might arise. For instance, if I discover that I need to know about subject X while working on Y," he says, "I know who to go to about X. These are all very positive benefits. It's quite a lovely place, indeed."

The Courant Institute Welcomes Robin Roy

Photo by Mathieu Asselin. ©NYU Photo Bureau.

We are delighted to welcome Robin Roy as Director of Development, Courant/Global Public Health, Science and Technology. Robin has a strong and successful background in development for basic science, having served as Director of Development for the Taub Institute for Research on Alzheimer's Disease and the Aging Brain at Columbia, Director of Development for Basic Sciences and Graduate Medical Education at Mt. Sinai Medical Center, and Associate Dean for Development and External Affairs for Columbia's Mailman School of Public Health. She comes to us from Barnard College, where she served as Senior Associate Director of Development.

Robin has an M.B.A. in Marketing from Columbia and an A.B. in English and M.A. in Musicology from Smith College. Her numerous achievements include developing a case statement for basic science research and managing the development program for the 10 basic science departments and three translational research institutes at Mt. Sinai, spearheading the reorganization of the Advisory Board for the Columbia School of Public Health, and negotiating and securing a $22 million gift from a Public Health school alumnus. She is a two time CASE (Council for Advancement and Support of Education) Circle of Excellence award winner.

Welcome, Robin!

Paul Garabedian Fellowship Established in Perpetuity

The Paul Garabedian Fellowship in Mathematics or Computer Science has been established in memory of Professor Emeritus Paul Garabedian. One of the outstanding mathematicians of his time, Paul spent 51 years of his career at NYU's Courant Institute, from 1959 until his death in 2010. The Fellowship has been established by his wife Lynnel Garabedian, with a generous $250,000 gift. The Fellowship will support students at the Courant Institute "who are members of groups traditionally underrepresented in post-graduate programs in science and mathematics, such as women and minorities."

Acting Director Michael Shelley said: "The Institute is deeply grateful to Lynnel for this gift that will support exceptional students through the years, in memory of Paul and his remarkable scientific legacy."

As a pure mathematician, Paul made fundamental contributions to the theory of partial differential equations and to the theory of functions of a complex variable. During the 1950s Paul was a pioneer in the use of computing to solve important scientific and engineering problems. His work as an applied mathematician has had a major impact on modern aircraft design and on the design of fusion reactors. "With much outstanding mathematics one can imagine the work having been done by a number of mathematicians," says Courant Professor Emeritus Peter Lax in the March 2014 *Notices of the American Mathematical Society*'s memorial article for Paul. "Not so with most of Paul's accomplishments; his outlook was unique. He will be remembered for a long time."

After receiving his B.A. from Brown (1946) Paul began his studies at Harvard, receiving his M.A. (1947) and then Ph.D. (1948) under the direction his advisor, Lars Ahlfors. He spent ten years at Stanford, with one intervening year at Berkeley, before James Stoker convinced Paul to move to the Courant Institute.

In 1964 Paul published *Partial Differential Equations*, a seminal text used worldwide even half a century after its publication. He advised twenty-seven Ph.D. students. From 1972-1978 he served as Director of the Courant Mathematics & Computing Laboratory of the US Department of Energy and was Director of the Division of Computational Fluid Dynamics from 1978 until his death. He was a member of the National Academy of Sciences, the American Academy of Arts & Sciences, and a fellow of SIAM and the American Physical Society. Among his many honors, Paul received the Boris Pregel Award from the New York Academy of Sciences, AMS's Birkhoff Prize, SIAM's Theodore von Karman Prize, and the National Academy of Sciences Award in Applied Mathematics and Numerical Analysis.

The Bieberbach Conjecture

One of Paul's earliest significant contributions was related to the celebrated Bieberbach Conjecture, which he worked on at Stanford along with Max Schiffer. "Their approach was to use the calculus of variations," says Peter Lax in the above mentioned AMS *Notices*. "The formulas involved in this research were formidable." Paul's contribution was an important step on the road to the conjecture itself being proved 30 years later, in 1985.

A lasting impact on aircraft design

In the 1970s advances in aircraft design were allowing planes to fly to nearly the speed of sound. Airflow over the wings would increase to supersonic speeds and generate shock waves which caused a greater drag on the airplane. Along with David Korn, a former Ph.D. student, Paul used mathematics and numerical methods to design airfoils for planes "that carry shockless transonic flows," says Peter Lax in the AMS *Notices*. "This required solving partial differential equations that are partly elliptic, partly hyperbolic. They accomplished this by introducing complex coordinates. This was so sophisticated a mathematical idea that the aerodynamic community was unable to comprehend it; therefore they ignored it. Finally a mathematically minded aerodynamicist in Canada tested the airfoil in a wind tunnel and found the flow to be indeed free of shocks. After that, aerodynamicists pounced on the Garabedian-Korn design." The resulting airfoils increased lift, fuel efficiency, and speed. This discovery revolutionized the industry and influences much of commercial aircraft design today. The research resulted in three books written by Paul and his team and was acknowledged with a NASA Public Service Group Achievement Award in 1976 and Certificate of Recognition in 1980.

Advancements in cleaner and safer energy

Paul worked on problems related to magnetic fusion—a way to generate carbon-free power and avoid the risks associated with nuclear energy—on and off for a period of forty-plus years. "He was very much interested in trying to find a way to develop magnetic fusion," says Courant Professor Emeritus Harold Weitzner, "because he considered it socially desirable." After years of fusion work, Paul developed sophisticated models. The result of Paul's work with his research group was the NSTAB suite of computer codes. The ideas and computations from these codes enabled others to develop the code which is now the standard for designing

Peter Lax and Paul Garabedian (1968) with the CDC (Control Data Center) 6600, the third in a line of supercomputers which were housed and operated in the basement of the Institute's Warren Weaver Hall. Paul served as Director of the Courant Mathematics & Computing Laboratory from '72-'78.

stellarators (machines for producing controlled fusion reactions in plasma), such as the large "heliotron" stellarator in Japan and a large new stellarator in Germany. "So this was a major contribution to the field," says Harold.

Paul worked tirelessly up until his death. His last paper, "The DEMO Quasisymmetric Stellarator," written with his former student Geoffrey McFadden (NIST), was published just four months before he died. During the last months of his life, Paul continued to come to Warren Weaver Hall regularly. There, he could be heard singing the praises of Lynnel, his wife of 43 years, who graciously attended to all the practicalities of their lives at that time "because," as he said, "all I can see is the beautiful math."

Paul was a devoted father to his daughters, Emily and Cathy, and immensely proud of them. He had always fervently believed in encouraging and promoting women in science and math and was delighted when they became scientists in their own right, Emily, a physician, and Cathy, a neuroscientist.

Giulia DeSalvo has been named the first recipient of the Paul Garabedian Fellowship in Mathematics or Computer Science. As stated by Giulia's Ph.D. advisor, Mehryar Mohri: "Giulia has introduced an important and novel machine learning model formed by cascades of predictors, Deep Cascades, in which leaf predictors or node questions may be linear predictors based on polynomial kernels of relatively high degree, neural networks, or members of other rich families." Congratulations, Giulia!

PUZZLE SPRING 2015

Take Your Seats

by Dennis Shasha and Richard Cole

A popular logic game involves figuring out an arrangement of people sitting around a circular table based on hints about, say, their relationships. In this puzzle, we aim to determine the smallest number of hints sufficient to specify an arrangement unambiguously. For example, suppose we must seat Alice, Bob, Carol, Sybil, Ted, and Zoe. If we are allowed hints only of the form X is one to the right of Y, it would seem four hints are necessary. But suppose we can include hints that still refer to two people, or "binary hints", but in which X can be farther away from Y.

As a warm-up, suppose we have just three hints for the six people: Ted is two seats to the right of Carol; Sybil is two to the right of Zoe; and Bob is three to the right of Ted. We see that we need only three hints to fix the relative locations of six people. What is a unique (up to circular shift) arrangement of the six people in this case?

Warm-Up: Solution to six people arrangement: a circular table with 6 people, where Carol to the left of Zoe, Zoe to the left of Ted, ..., Bob to the left of Carol: (Carol, Zoe, Ted, Sybil, Alice, and Bob).

However, if we now bring Jack and Jill into the picture, for a total of eight people, then we might ask how many binary hints we would need to fix the arrangement. Consider these five hints: Carol is three seats to the right of Jill; Alice is six to the right of Bob; Ted is four to the right of Zoe; Jill is six to the right of Zoe; and Carol is six to the right of Sybil. What arrangement would these hints produce?

Getting even more ambitious, suppose we add Christophe and Marie, giving us 10 people, and want the ordering to be like this: Christophe, Jack, Jill, Bob, Marie, Carol, Ted, Zoe, Alice, and Sybil.

Can you formulate seven hints that will fix this arrangement? Can you do it with fewer than seven?

In general, how many binary hints are required to fix an arrangement of n people around a table for n at least six? Can you achieve $3n/4$? Can you do better than this? We don't know the answer to the last question.

For the solution, email: courant.alumni@nyu.edu

WELCOME TO THE INSTITUTE'S NEWEST FACULTY

Yuri Bakhtin joined the Institute in Fall 2014 as an Associate Professor of Mathematics. He received his Ph.D. in mathematics from Moscow State University (2001). Prior to coming to Courant, he taught at the Georgia Institute of Technology. His primary areas of research are in random dynamics and probabilistic models of mathematical physics.

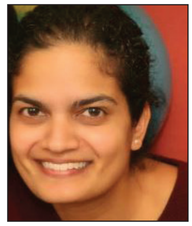
Amos Bloomberg joined Courant in Fall 2013 as a Clinical Assistant Professor of Computer Science, following 15 years in the internet and media sectors designing apps, games, and toys. He holds a bachelors in Brain & Cognitive Sciences from the University of Rochester (1997), and a masters in Interactive Telecommunications from NYU (2003).

Joshua Clayton joined the Courant Institute in Fall 2013 as a Clinical Assistant Professor of Computer Science. His work explores the creative potential of computational media, with a particular focus on the Web. He received a master's degree in Interactive Telecommunications from New York University in 2011.

Joanna Klukowska joined the Courant Institute in Fall 2014 as a Clinical Assistant Professor of Computer Science. She received her Ph.D. in 2013 from the Graduate Center of the City University of New York where her research work was in biomedical imaging. More recently she became interested in computer science education and introducing students to open source projects.

Alex Mogilner joined NYU in Fall 2014 as a Professor of Mathematics and Biology. Alex received Ph.D. in Applied Mathematics from the University of British Columbia in 1995, worked at UC Berkeley as a postdoc, and from 1996 to 2014 was a Professor at the Departments of Mathematics and Neurobiology and Physiology at UC Davis. Alex's fields of study include Mathematical Biology, Cell Biology and Biophysics. He works on mathematical and computational modeling of cell motility and cell division, and conducting experimental research on galvanotaxis.

Mike O'Neil, Assistant Professor of Mathematics at Courant and the School of Engineering as of Fall 2014, received his Ph.D. from Yale in Applied Mathematics in 2007. Previously, he served as an Associate Research Scientist and Courant Instructor. His research focuses on numerical analysis and fast algorithms for integral equation methods in electromagnetics, acoustics, and fluids.



Vindya Bhat's research interests include Ramsey Theory and extremal combinatorics. She received her B.A. from Rutgers University (2000), M.A. from Columbia University (2007) and Ph.D. from Emory University (2015). Prior to joining the Courant Institute in Fall 2014 as a Clinical Instructor of Mathematics, Vindya gained 10 years of industry experience in various analytical roles.

Paul Bourgade joined the Institute in Fall 2014 as an Associate Professor of Mathematics. He received his Ph.D. in Mathematics from Université Paris 6. His research lies in probability theory (random matrices, stochastic analysis) and its connections with other domains of mathematics (partial differential equations, analytic number theory).

Miranda Holmes-Cerfon joined the Institute as an Assistant Professor of Mathematics in Fall 2013. Her work lies broadly in two areas: self-assembly of nano- and micro-scale systems, and multiscale processes in fluids. She has investigated these in a range of applications, including soft-matter physics, colloids, sphere packing, ion beam sputtering, internal waves, ocean mixing, tides, and lava tubes.

Eyal Lubetzky joined the Institute in Fall 2014 as an Associate Professor of Mathematics. His main research interests are probability theory and combinatorics, with an emphasis on interacting particle systems, random networks and stochastic processes arising from statistical physics. Previously, he was a Senior Researcher in the Theory Group of Microsoft Research, Redmond, where he spent 7 years, starting as a post-doctoral researcher. He received his Ph.D. in Mathematics from Tel-Aviv University in 2007, and received the Rollo Davidson prize in 2013.

Michael Munn joined the Courant Institute in Fall 2014 as a Clinical Assistant Professor of Mathematics. He received his Ph.D. from the CUNY Graduate Center in 2008 and spent two years at the University of Warwick as an NSF postdoctoral fellow. His research interests are in geometric analysis and metric geometry, as well as an interest in undergraduate mathematics education.

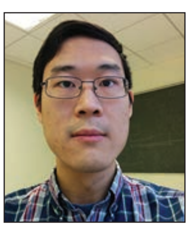
Mutiara Sondjaja joined the Courant Institute in Fall 2014 as a Clinical Assistant Professor of Mathematics. She received her undergraduate degree in Mathematics from Harvey Mudd College (2008) and her Ph.D. in Operations Research from Cornell University (2014). Her mathematical interests are continuous optimization and mathematical programming.

Georg Stadler joined the Institute in Fall 2014 as an Associate Professor of Mathematics. He received a Ph.D. from the University of Graz in Austria in 2004 and previously held a Research Scientist position at the Institute of Computational Engineering and Sciences at UT Austin. His main research interests are in parallel scientific computing, deterministic and probabilistic inverse problems and PDE-constrained optimization. Much of Stadler's research is driven by application problems in the earth sciences, such as the flow in the earth's mantle, seismic wave propagation and the dynamics of ice sheets.

Elizabeth Stepp joined the Institute in summer 2013 as a Clinical Assistant Professor of Mathematics. She received her B.S. in mathematics form Vanderbilt University (1992) and her Ph.D. in mathematics from the University of Kentucky (2005). Before joining Courant, she spent six years on the faculty at the University of Texas at Austin.

Joseph Versoza joined Courant as a Clinical Assistant Professor of Computer Science in Fall 2014. His interests include developing modern web applications and integrating professional programming tools into computer science education. Versoza holds an MPS from NYU's Interactive Telecommunications Program. He has several years of experience in IT management, software engineering and technology education.

Michael Walfish joined Courant as an Associate Professor of Computer Science in 2014. He was previously on the faculty at UT Austin, and received his Ph.D. in Computer Science from MIT. His research interests are in systems, security, and networking; a particular focus over the last several years has been verifiable outsourcing of computations based on complexity-theoretic and cryptographic machinery.

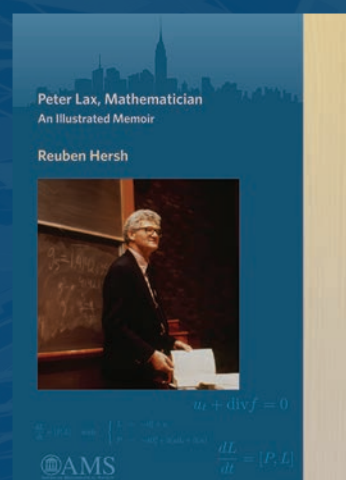


Robert Young joined the Courant Institute in Fall 2014 as an Associate Professor of Mathematics. He received his Ph.D. from the University of Chicago in 2007 and previously held a faculty position at the University of Toronto. His research interests include quantitative geometry in Lie groups and the structure of surfaces in Euclidean space and nilpotent groups.

Computer Science Students Best All of North America in Global Computer Programming Contest

A team of computer science students from NYU's Courant Institute bested the 20 other North American schools competing in the 2014 World Finals of the ACM Intercollegiate Programming Contest (IPC). The team — comprising Bowen Yu, Fabian Gundlach, and Danilo Neves Ribeiro — placed 13th out of 122 schools from across the globe. They were coached by Evan Korth, Clinical Professor of Computer Science, and adjunct faculty members Brett Bernstein and Sean McIntyre. The ACM IPC, sponsored by IBM, is the first global programming competition conducted by and for the world's universities.

Peter Lax, Mathematician: An Illustrated Memoir



This new biography about Peter Lax, written by Reuben Hersh, was published by the American Mathematical Society in early 2015. "Reuben Hersh, one of Peter's many students, gives us a lively and beautifully illustrated biography," says Gérard Ben Arous, Director of the Courant Institute of Mathematical Sciences. The book chronicles Lax's life, including his and his family's escape to the U.S. as the Nazis invaded Hungary, his work on the Manhattan Project, his arrival at the Courant Institute (before it was named for Richard Courant), and his lifetime as one of the most influential and renowned mathematicians of both pure and applied mathematics. "This book brings out both the personal and professional aspects of Peter's work in a captivating manner," says Ben Arous. "It is a great read for people who know Peter as well as for those who do not."

FACULTY HONORS

Richard Bonneau was appointed Group Leader for Systems Biology at the Simons Center for Data Analysis, where he leads a group focused on developing new computational biology methods.

Antoine Cerfon and **Miranda Holmes-Cerfon** were selected for *Department of Energy Early Career Research Awards*. The Early Career program "supports the development of individual research programs of outstanding scientists early in their careers." **Antoine** was selected by the Office of Fusion Energy Sciences for his work on "High Performance Equilibrium Solvers for Integrated Magnetic Fusion Simulations" and **Miranda** by the Office of Advanced Scientific Computing Research for her work on "Kinetics of Particles with Short-Range Interactions."

Jeff Cheeger was named a 2013 Simons Fellow in Mathematics by the Simons Foundation. Simons Fellows, selected for demonstrated research accomplishment, are given financial support to extend the duration of their sabbatical research. He also gave the 2013 Tondeur Lectures (U. Illinois, Urbana-Champaign) and the 2014 Bowen Lectures (U. C. Berkeley) on Quantitative Behavior of Singular Sets.

Patrick and **Radhia Cousot** were awarded the 2014 Harlan D. Mills Award for "the invention of 'abstract interpretation,' development of tool support, and its practical application." The award is given annually by the IEEE Computer Society to recognize "researchers and practitioners who have demonstrated long-standing, sustained, and meaningful contributions to the theory and practice of the information sciences, focusing on contributions to the practice of software engineering through the application of sound theory."

Patrick Cousot and **David McLaughlin** have been named Julius Silver, Roslyn S. Silver, and Enid Silver Winslow Professors. Funded by an endowment to the University from alumnus Julius Silver, Silver Chairs are awarded in recognition of outstanding scholarly contributions.

Rob Fergus won the 2013 IEEE CVPR (Computer Vision and Pattern Recognition) Longuet-Higgins prize for his 2003 paper "Object Class Recognition by Unsupervised Scale-Invariant Learning" with Pietro Perona and Andrew Zisserman. The prize is awarded for "fundamental contributions in computer vision."

Leslie Greengard was selected to give the 2014 *John Von Neumann Lecture* at SIAM. The distinguished prize series, established in 1959, is awarded "for outstanding and distinguished contributions to the field of applied mathematical sciences and for the effective communication of these ideas to the community." In September 2013, Greengard was named *Director of the Simons Center for Data Analysis* at the Simons Foundation, where he is building and leading "a team of scientists committed to developing innovative mathematical methods and software for analyzing large-scale data sets drawn from the biological and physical sciences."

Selin Kalaycioglu won a 2014 NYU Golden Dozen Award from NYU's College of Arts and Science. The award, selected from nominations sent in by students and faculty, "recognizes faculty for their outstanding contribution to learning in the classroom."

Bob Kohn and **Louis Nirenberg** received the 2014 AMS Leroy P. Steele Prize for Seminal Contribution to Research, along with Luis Caffarelli. They received the honor for their paper, "Partial regularity of suitable weak solutions of the Navier-Stokes equations" (Communications on Pure and Applied Mathematics, 1982) which, as expressed in the AMS citation, "was and remains a landmark in the understanding of the behavior of solutions to the Navier-Stokes equations and has been a source of inspiration for a generation of mathematicians."

Yann LeCun was awarded the 2014 IEEE Computational Intelligence Society Neural Networks Pioneer Award, recognizing "significant contributions to early concepts and sustained development in the field of neural networks."

Andrew Majda was awarded the 2015 ICIAM Lagrange Prize "in recognition of his ground-breaking, original, fundamental and pioneering contributions to applied mathematics and, in particular, to wave front propagation and combustion, scattering theory, fluid dynamics and atmosphere climate science." The Lagrange Prize was established "to provide international recognition to individual mathematicians who have made an exceptional contribution to applied mathematics throughout their careers."

The Centre de Recherches Mathématiques, a Canadian mathematical research center, has established the CRM Nirenberg Lectures in Geometric Analysis in honor of Courant Professor Emeritus **Louis Nirenberg**.

Theodore Rappaport and his students have been awarded the 2015 IEEE Donald G. Fink Award for the outstanding survey, review, or tutorial paper in IEEE publications.

John Rinzel is the recipient of the 2015 Arthur T. Winfree Prize from the Society for Mathematical Biology for "his elegant work on the analysis of dynamical behavior in models of neural activity and the contributions that work has made in the neurobiological community to the understanding of a host of phenomena (including simple excitability as well as bursting) in single neurons, small populations of neurons, and other excitable cells."

Dennis Shasha was named a 2014 ACM Fellow for both technical and literary contributions to computing. His technical contributions include ways to maximize concurrency in database indexes and fast algorithms for finding correlations and bursts in time series. His literary contributions include a wide-ranging study of database tuning, books on resampling statistics, DNA computing, and mathematical puzzles.

David Sontag and **Thomas Wies** have each received NSF CAREER awards. CAREER awards are the National Science Foundation's "most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations." **Sontag** was selected for his project "Exact Algorithms for Learning Latent Structure" and **Wies** for "Abstracting Programs for Automated Debugging."

Daniel Stein was awarded a 2014 John Simon Guggenheim Fellowship in Natural Sciences in a group of 178 scholars, artists, and scientists. Fellowships are awarded "on the basis of prior achievement and exceptional promise."

Yuri Tschinkel was named an American Association for Advancement of Science Fellow for "outstanding research in algebraic geometry and number theory and dedicated service as the Director of Mathematics and the Physical Sciences at the Simons Foundation." AAAS Fellows are named for their "distinguished efforts to advance science or its applications."

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Louis Nirenberg shares 2015 Abel Prize with John Nash

by April Bacon

Photo by Mathieu Asselin. ©NYU Photo Bureau.

Louis Nirenberg has won the Norwegian Academy of Science and Letters' 2015 Abel Prize along with co-recipient John Nash. The Abel Committee selected these "two mathematical giants of the twentieth century" for their "striking and seminal contributions to the theory of nonlinear partial differential equations and its applications to geometric analysis." The prize will be formally presented by King Harald of Norway in Oslo in May 2015.

Though only 16 Abel prizes have been awarded, Louis is the fourth Courant faculty member to win the prize. The other three recipients are Peter Lax (2005), S. R. Srinivasa Varadhan (2007), and Mikhail Gromov (2009). "It really is phenomenal," Donald E. McClure, executive director of the American Mathematical Society, told *The New York Times* for its 2009 article "Complex Math, Simple Sum: 3 Awards in 5 Years." "[The Abel Prize] has the same distinction as a Nobel Prize, and there's no other institution in the United States or in the world that has had such a concentration of these awards."

As the Abel committee elaborates in their citation, Nirenberg's and Nash's "breakthroughs have developed into versatile and robust techniques that have become essential tools for the study of nonlinear partial differential equations. Their impact can be felt in all branches of the theory." The full citation, available at the 2015 Abel Prize website, gets a bit technical. According to Courant Professor Bob Kohn, "it weaves together Nirenberg's and Nash's themes in a most remarkable, almost poetic way."

"Partial differential equations lie at the foundation of many areas, both within and beyond mathematics," explains Bob. "They are the language we use to describe -- and the tools we use to understand -- problems in diverse areas including geometry, engineering, and physics."

"This is not a joint award because the committee couldn't decide between Nirenberg and Nash," noted Bob at the Courant Institute's March 30th celebration for Louis. "Rather, it is joint because of parallels between their mathematical styles and impact. The most obvious connection is by area: geometric analysis and elliptic regularity are two subjects where both have made essential contributions. But there is also a more subtle connection: beyond solving important problems, each has introduced important methods and tools, which have become essential parts of the fabric of our field."

Although the pair never formally collaborated on papers, they influenced each others' work and, as added in the Abel prize citation, "the consequences of their fruitful dialogue, which they initiated in the 1950s at the Courant Institute of Mathematical Sciences, are felt more strongly today than ever before."

Louis' importance to mathematics in general and specifically to the life and prominence of the Courant Institute—of which he has been a member for seventy years—is foundational. He joined the Courant Institute (not yet named for Courant) in September 1945 as a graduate student. He received his M.S. in 1947 and his Ph.D. in 1949 under James Stoker, after which Richard Courant immediately hired him onto the faculty.

Since then, Louis has received numerous awards, including the National Medal of Science, the American Mathematical Society's Leroy P. Steele Prize for Lifetime Achievement (1994) and for Seminal Contribution to Research (in 2014 with Bob Kohn and Luis Caffarelli), the AMS Bôcher Memorial Prize, the Jeffrey-Williams Prize of the Canadian Mathematical Society, the Royal Swedish Academy of Science's inaugural Crafoord Prize (with Vladimir Arnold), and the International Mathematical Union and Chern Medal Foundation's inaugural Chern Medal. He was elected to the National Academy of Sciences in 1969.

Professor Jalal Shatah, who came to Courant as a postdoc after graduate studies at Brown, recalls: "The first thing I learned [about Louis] was that his mathematical contributions went far beyond the ones I had learned about as a student. When I realized this, my admiration of his work -- already very high -- became even greater."

Jalal also quickly learned that, for Louis, math is not just a passion: it is also about fun and beauty, two things which are central to Louis as a mathematician and a person. His appreciation of beauty extends into his admiration of artful objects like ceramics and masks and his love of fine foods. And his dedication to fun is exhibited by his love for telling jokes. "One thing I never told him," says Jalal, "was that I translate his jokes into Arabic and tell them to my friends and relatives in Lebanon. Some of the jokes are lost in translation but most are a big hit."

But the most important thing Jalal quickly learned was the depth of Louis' kindness: "He is the kindest man I have ever met," says Jalal. "His gentleness and kindness supersede anything I could ever have imagined." Louis' enormous mathematical contributions are matched only by his gentleness as a human being. As noted in the biography of Louis posted on the Abel Prize's website: "his generosity, gift for exposition and modest charm have made him an inspirational figure to his many collaborators, students and colleagues."

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Please send the details to **alumni.news@cims.nyu.edu**.

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