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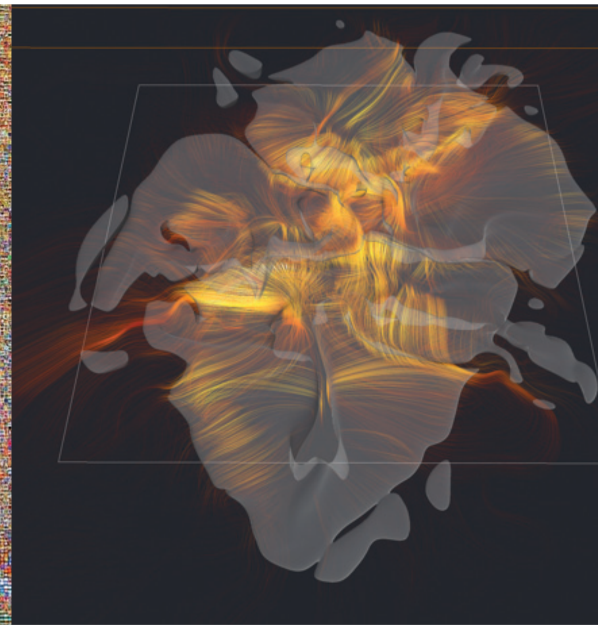
CIMS Newsletter

The Courant Institute of Mathematical Sciences at New York University

Spring 2012



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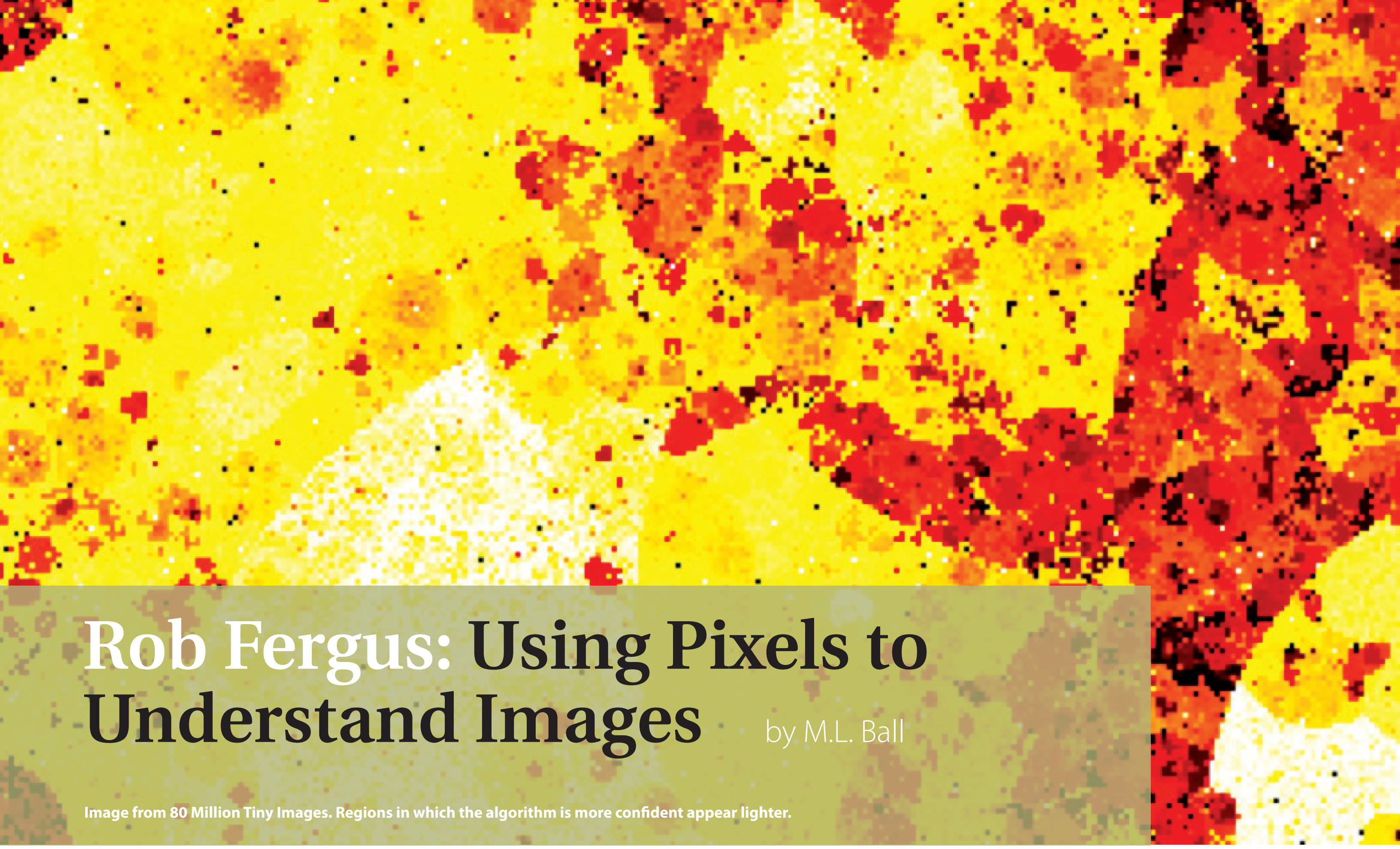


Rob Fergus: Using Pixels to Understand Images

by M.L. Ball

Image from 80 Million Tiny Images. Regions in which the algorithm is more confident appear lighter.

An Englishman with a propensity for juggling multiple projects at once, Rob Fergus, Assistant Professor of Computer Science, received his undergraduate degree in Engineering from Cambridge University and his Ph.D. from Oxford University. Following postdoctoral work at MIT, Rob then made his way to Courant.

"I mainly work on computer vision, which tries to understand images," Rob said. "I look at pixels and build models of how they vary, then apply those models to image processing and object recognition, trying to understand the contents of an image. I also do machine learning, which is the more statistical side of it – trying to get computers to learn from visual images."

Rob recently discussed several projects spanning his broad range of research interests.

Indoor Scene Segmentation Using a Structured Light Sensor

The first project Rob described has been made possible by the Microsoft Kinect, a gaming device that produces an image and a depth signal. Rob explained, "When you put the Kinect in front of your TV, it can recognize what you're doing with your body because it uses special hardware to directly measure depth at each pixel. For computer vision researchers, this is an absolute godsend because trying to reliably extract the depth from an image is actually quite hard. Using these sensors, we can now improve our algorithms for recognizing things."

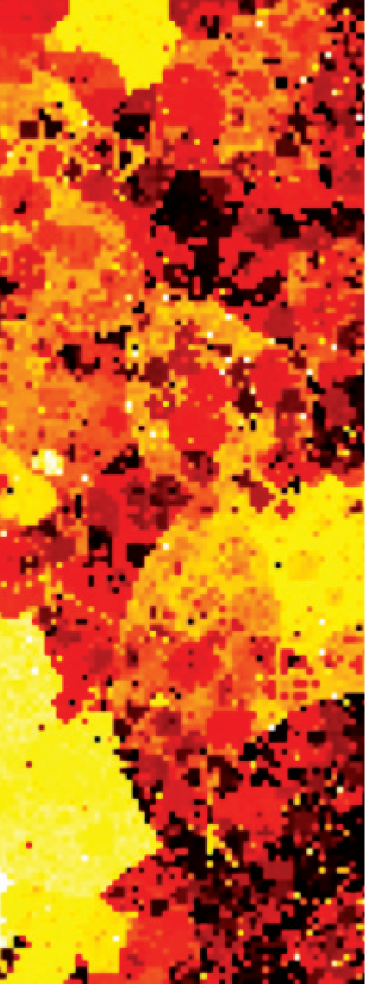
The project's goal is to recognize indoor scenes to help blind people. Nektarios Paisios, a blind Ph.D. student at Courant who is profiled on page 7, was involved in writing the proposal.

Speaking in his office, Rob said, "We have an image of say, this office, but for each pixel we also have a depth. The first part of the project is to work out how to use the depth signal from the Kinect to improve on the performance. We'd like to know, for example, that this desk is a surface you can sit on, or this bottle is being supported by this desk. The second stage will be trying to figure out how to take our operative algorithm and give it to blind people in a way that's useful for them, so that when a blind person walks into an office for the first time, he knows that there's a chair or sofa he can sit on, for instance."

The challenge is trying to find a way to present this information without overloading a blind person. "There's an intriguing way of doing it which involves putting a sensor on the tongue, sort of an array of little pins that can vibrate," Rob said. "There are lots of nerve endings on your tongue, so with some practice you could actually learn to see with this in a very crude way. We're hopeful that our system will be able to transmit information about the density of an object via this sensor so that a blind person could ascertain that the object is a chair rather than a desk."

Learning Invariance Through Imitation

A Dutch rock band, eager fans, and a bit of serendipity all come into play for this next project.



According to Rob, "This was a fun project with Chris Bregler, who works on trying to understand human actions. One of the problems with an image of a person is trying to understand what pose they're in. This is difficult because people wear quite different clothing and when you take photographs of them, there might be all kinds of objects in the background that are very distracting. Also, trying to exactly determine the pose of an individual is quite hard because there are many different ways the body can move. We were looking for a clever way of finding training data for our algorithms where we had people in the same pose but in a range of different clothing, backgrounds and lighting conditions."
Purely by chance, a Dutch rock band had taken a video of themselves, then took still frames from the video and asked their fans to imitate the poses of the band members. "So what you have are all these fans with their web cams striking the same poses as the band guys," Rob said, laughing, "providing us with a whole data set of exactly the same pose with all the variations we were trying to capture. We trained the algorithms to ignore all those things and just produce the same pose estimate from all those different examples."

Rob added, "We did eventually contact the Dutch rock band's manager and apparently, the band thinks it's really cool that we're using their artistic video for science."

Dark Flash Photography

"The genesis of this project was that I was in a bar with some friends and we tried to take a picture," Rob said. "The bar being dark, we all got dazzled by the flash and I thought, 'This is just dumb. Why do I have to be dazzled to have my picture taken, and is there some way you can take a photograph in low light conditions without that happening.' I looked for a way to add light to the scene in a way you wouldn't notice but that the camera would pick up, like an invisible camera flash."

Rob came up with the idea of creating a flash that shines light just outside visible wavelengths. "You will notice a little bit of it because your eye is sensitive to between 400 and 700 nanometers, and the flash energy is just at the edges of that, but most of it will only be picked up by the camera. The colors will be weird, so you take a second image straight after the first without a flash and using a very short exposure. The colors are roughly correct because you're using the weak ambient light. Because you took one right after the other, the two images are aligned with the edges in the same positions, so you can use the flash image to tell you where to sharpen or smooth the noisy ambient image to get a clean image with natural colors."

Rob and his graduate student, Dilip Krishnan, built a prototype camera, filed a patent on it through NYU, and have actually had some interest from camera manufacturers in licensing it.

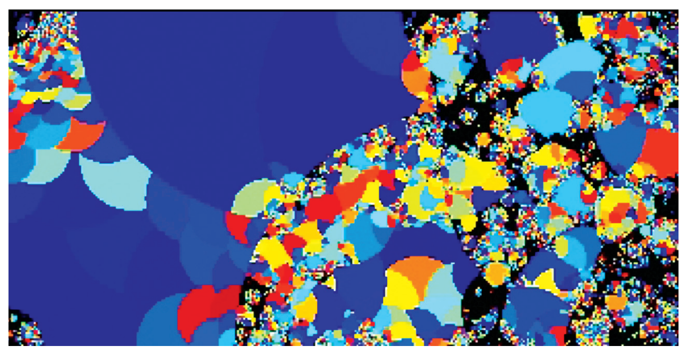
80 Million Tiny Images: A Large Dataset for Non-Parametric Object and Scene Recognition

Rob described his next project as a response to today's huge data sets and the challenge of extracting useful stuff from them. "The problem is that a lot of the algorithms we have for understanding pictures only work on a few hundred images, not millions or billions," he explained. "The types of algorithms that would work better on huge collections of images need to be simple ones. So in this project we collected 80 million images off the Internet and tried some very simple things with them, such as 'nearest neighbor' – the easiest way of classifying an image by looking at images that are similar to it and copying their labels."

This method proved to be very effective but requires vast amounts of data. "This is something people are finding in other areas," Rob said, "that with lots of data, even very simple models allow you to do very exciting things."

Rich collaboration on the 12th floor of 719 Broadway

In the dual fields of computer vision and machine learning, Rob has several colleagues with whom he frequently collaborates. "I track quite closely with Yann LeCun who's in machine learning, with David Sontag who's also in machine learning and on the more theoretical side of what I do, and with Chris Bregler who's interested in how humans move. And I talk to Denis Zorin when I have a math problem because a lot of the tools we use are similar." ■



Visualization showing how the mosaic is divided into semantic groups. Each region of flat color corresponds to a collection of related terms as defined by WordNet.

Visualization of 53,464 English nouns arranged by meaning. Each tile shows the average color of the images that correspond to each term.

Olivier Pauluis: Studying the Atmosphere In Order To Better Predict Climate

by M.L. Ball

Olivier Pauluis, a native of Belgium, earned his B.S in engineering and applied mathematics from the Université Catholique de Louvain in Louvain-la-Neuve, Belgium. It was his undergraduate advisor, Dr. Andre Berger, a climatologist, who sparked his interest in his present field by introducing him to the Ice Age. Naturally, when Olivier came to the U.S. to pursue his Ph.D. at Princeton under the supervision of Dr. Isaac Held, it was in atmosphere and ocean sciences. Following postdoctoral work at MIT, Olivier is now an Associate Professor of Mathematics in the Center for Atmosphere Ocean Science at the Courant Institute.

Possessing an enthusiastic personality and a penchant for lime green, Olivier Pauluis recently discussed his current research, beginning with his impressions of the Courant Institute. "My background is in mathematical physics so Courant is a bit scary because it has such a strong reputation in math," he said. "It's a very unique place in the mathematics world and it's very nice because there are a lot of mathematicians who are interested in figuring out mathematical tools and what we can do with them." He added, "Being here has been a very fruitful experience."

Joining modern applied math and climate atmosphere ocean

When describing the work of the Center for Atmosphere Ocean Science, it quickly became obvious that Olivier loves his work. "A lot of what we do is physical modeling of the atmosphere and trying to formalize this system into equations," he said. "Then we try to solve the equations and once we've solved them, we try to infer something about the physics of the system. It's a back and forth between math and physics, so sometimes you focus on the math and try to improve the technique, and sometimes you focus on the physics and try to make sense of the equations."

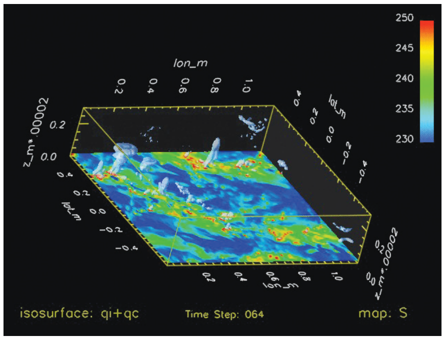
Olivier's group is largely focused on working with very complex models that produce terabytes upon terabytes of data. "They produce so much data that you need to be smart about how you look at it to understand what's happening in the climate system," he said. "We're also trying to improve the way we simulate the climate."

Research interests include climate, large-scale atmospheric circulation, tropical meteorology and moist convection

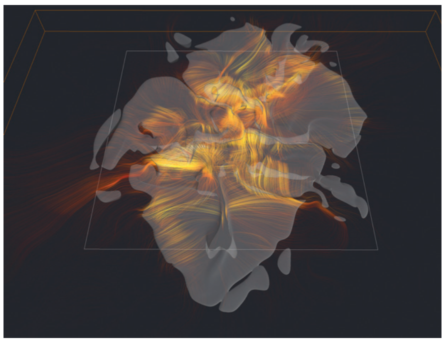
First and foremost, Olivier is interested in figuring out how the climate system works – particularly how the atmosphere transports energy and momentum around the earth and how that affects the distribution of climate – with the goal of achieving a better prediction of climate.

As an example, the climate we experience here in New York in the mid-latitudes is comprised of alternates of good and bad weather. Every three to five days, the weather will change. "That's typical of the mid-latitudes, anywhere between 30 and 60 degrees latitude," Olivier explained. "In the subtropics, you find big desert areas and in equatorial regions, monsoons and a lot of rain. These different climate regimes are tied to the fact that there is a broad atmospheric

Image Above: **Cloud field in numerical simulations of moist Rayleigh Benard convection.** (For more information on the simulations, see Pauluis and Schumacher, PNAS, 2011)



Air parcel trajectories inside a cloud.



Three-dimensional cloud field (gray shading) and boundary layer entropy in numerical simulation of tropical convection.

circulation that moves air and transports water, energy and momentum."

One of the properties of this atmospheric circulation is chaos. "The theory of chaos is fairly old but it was resurrected in the 1960s by Ed Lorenz, a meteorologist at MIT," Olivier said. "He came up with simplified equations that represent the atmosphere and showed that these had chaotic properties and were very hard to predict. The equations that we're trying to solve in atmospheric sciences are very often chaotic."

Atmospheric science: trying to distinguish between two different types of predictability

In the field of predictability, according to Olivier, there are two types: predictability of the first kind and predictability of the second kind. "Predictability of the first kind pertains to trying to make a weather forecast," he said. "I know the weather conditions today and I want to know three days from now exactly what the weather will be like. That's very limited. We can make forecasts maybe five days ahead of time. That's about the edge of what we can do, and it depends on how good your observations are, how good your models are, and how clever you are with math."

Then there is predictability of the second kind "where you're not trying to predict what the weather is going to be at a specific point in time. You're trying to predict statistical properties, which is long range weather forecast," he said.

He continued, "We're not trying to forecast the weather a century from now, but based on our understanding of climate systems, it's very likely that the temperature is going to be on average much warmer in a century. Related to this, a lot of our work is trying to describe large scale circulation, the statistical properties of the system and averages. In effect, we study how multiple weather systems interact with each other and how they move water and energy around the globe."

Weather forecasting got its start in World War II

"We were flying a lot of planes over Germany and wanted to forecast the weather in order to know if pilots could fly," Oliver said. "On top of that, there were a lot of people flying during that time so we learned a lot about the atmosphere. Then once we had computers, we started to solve some of these equations that had been known for a while but that no one had been able to solve. It's still a fairly young field by scientific standards; there are still a lot of questions that need to be addressed," he added.

No other planet has as much rain as Earth

According to Olivier, "the Earth's atmosphere is quite interesting because of water and water vapor. In that regard it's very different from the atmosphere of other planets. Because water in the atmosphere exists in three phases (gas, liquid, and solid) and is changing states continuously – that's why we have clouds. Clouds occur when the water vapor in the air is lifted; then when it cools, it condenses to form water droplets. This is very unique and doesn't happen on other planets, like Jupiter or Saturn. If you look at a satellite map of the Earth, you see all these big swirling motions of clouds. You won't see that on other planets."

From a physics point of view, Olivier said, approximately 80% of the energy that the atmosphere receives from the Earth's surface is evaporation of water vapor that condenses. "We know the equation to describe the motion of clouds but clouds are very complicated," he said. "They're four-dimensional with multiple variables. We can't solve it on our own but we can use the supercomputer to look at a simulation and try to understand it. We can also find some smart mathematical way of solving equations more easily or cheaply without having to use as much computation, with the goal being able to make better predictions. We're trying to reproduce what's happening here on Earth and trying to predict a change."

Clouds and global warming: very closely tied

Olivier stressed that clouds have a very big impact on climate because they reflect a lot of solar radiation and therefore greatly influence the amount of energy the Earth receives. "With the planet getting warmer," he posed, "the question is, will there be more clouds or fewer clouds…and which type of clouds will they be?"

When asked if we're in trouble here on Earth because of the long-term changes being made to the atmosphere, Olivier answered emphatically, if also a bit ominously, "It's definitely getting warmer. And every decade will probably be warmer than the previous one." ■

Babu Narayanan: The Quest for 21st Century Medical Breakthroughs

by M.L. Ball

Courant Institute alumnus Babu Narayanan: GE Global Research Technology Leader

GE Global Research, headquartered in Niskayuna, NY, operates industrial research labs in India, China, Germany, Israel, California and soon in Brazil. Babu Narayanan is the Technology Leader in Biosignatures and Signal Processing in the Diagnostics and Biomedical Technologies domain at the John F. Welch Technology Centre in Bangalore, India, the world's largest GE technology site.

Directs two labs in Bangalore, India and two in upstate New York

Taking a break from a full day of meetings at the Courant Institute before boarding a plane to India, Babu Narayanan generously spent an hour explaining his current projects at GE Global Research, the future of personal medicine, and the satisfaction he gets from generating new innovations in health care.

"I'm based in Bangalore but I also spend time in Niskayuna," Babu said. "Thanks to advanced information technology, I can be in India and still lead the labs here. In New York, we have a computational biology and biostatistics lab and a biomedical image analysis lab. In Bangalore, one is a medical image analysis lab and the other is a biomedical signal processing lab."

Explaining in more detail, he said, "We carry out research towards advanced quantitative imaging and visualization applications in medical imaging on MRI, PET, CT, Ultrasound, and inverse problems in imaging, and we work on new platforms and applications in molecular diagnostics. In all of these, we work closely with several partners—physicists, biologists, chemists, software & hardware engineers and clinicians—to help take ideas all the way from concept to commercially successful product."

The 21st century: the century of biology

Throughout its 136 years, GE has steadfastly been about innovation. "The slogan we have for GE is 'Imagination at Work,'" Babu said. "Very recently, we launched a campaign called 'GE Works.' Powering, building, curing, moving is our goal; what we do is just the means to those objectives."

Babu then stated emphatically, "I think the 21st century really has the potential to be the century of biology. We want to have the capability via diagnostic imaging and blood- or tissue-based tests to catch disease early and potentially avoid disease altogether. For enhancements to happen, we need to be able to understand biology a lot better and marry it with algorithms. Biology meeting mathematics and computer science is something we do in diagnostic imaging, but we're going to do a lot more of it in computational biology going forward," he said.

Molecular diagnostics will soon make personalized medicine the standard

"Gone are the days when you have a generic therapy for all people with a particular illness," Babu said. "We are going to find the right therapy and the right dosage level for that individual. In the future, medicine is going to be very individualized. There's a lot of innovation, a lot of technology that's required to do molecular diagnostics and that's one of the big initiatives for us at GE Healthcare and GE Research."

He continued, "We are currently developing a breakthrough platform for multiplexed immunohistochemistry that allows us to image as many as a hundred proteins simultaneously within cell compartments on a single sample of tissue. We think this will be very useful in cancer research as well as when we want to run a complex biosignature on a very small and precious sample."

At Courant during the early days of computational biology

After receiving his undergraduate degree at the Indian Institute of Technology at Madras, Babu came to the Courant Institute for his Ph.D. (1993) in theoretical computer science. "I did my Ph.D. with Joel Spencer and Ravi Boppana," he said. "I was a post doc at Rutgers at the Center for Discrete Mathematics and Theoretical Computer Science and at the Institute for Mathematics and its Applications at Minnesota. I also got an M.S. in math at Urbana." He added, "It's been extremely useful to have a strong background in computer science and mathematics."

Babu recalled that when he was at Courant, it was the very early days of computational biology. "It was ten years before the genome was sequenced but there was a lot of interest in marrying computer science and biology."

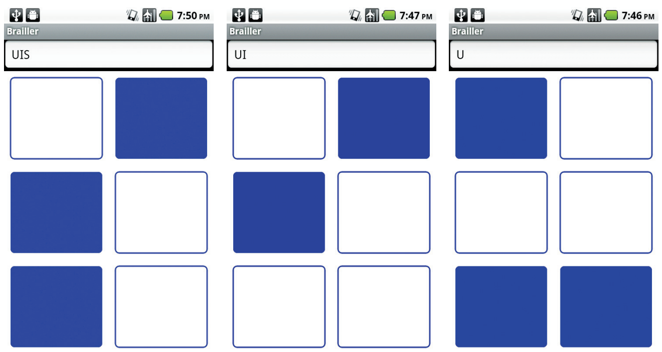
"If the last ten years were about the consumer Internet, the next ten years will be about the Industrial Internet." - *Bill Ruh, VP, Global Software Center, General Electric, San Ramon, CA*

A major area of interest at GE Research is software and analytics, primarily because of the abundance of data being generated today. "Making important decisions using that data is going to be the focus of the Industrial Internet," Babu explained. "It's a new Industrial Revolution, and it's driven by the abundance of quality data accessible anywhere because of good sensors, communication technology and the Internet."

Babu is also excited about the Courant Institute's major new initiative, The Center for Data Science. He said, "I am really happy to see Courant set up this new center. It is great to see Courant recognize the importance of big data and the role that applied math, computer science and data analysis can play working with domain experts to bring the Industrial Internet to fruition." ■

Nektarios Paisios: Finding New Ways for the Blind to See the World

by M.L. Ball



Screenshots of an application designed for the iPhone that allows messages to be typed using Braille.

A native of Cyprus, Nektarios Paisios is a recipient of the International Fulbright Science and Technology Award and the Google Lime Scholarship for Students with Disabilities. Upon completion of his doctorate from the Courant Institute this spring, he will begin a career with Google here in New York. Nektarios is blind.

Some graduate students juggle two, maybe even three projects at a time in pursuit of their Ph.D. Nektarios Paisios is currently working on four, hoping to complete at least three of them in order to earn his doctorate in May.

Tracking indoor location and motion to help the blind navigate unfamiliar environments

The first of Nektarios' projects, informally called 'Electronic Guide Dog,' uses mobile phone software to help visually impaired people navigate unfamiliar environments, particularly building interiors.

"Given that I myself am blind, I was looking for a research topic that would be personally interesting to me in my everyday life," Nektarios said. "I am trying to develop a system that will map out the interior of a building effortlessly without having to involve building staff."

Nektarios explained, "Using a mobile phone and a building's existing Wi-Fi infrastructure, you can use the signals from Wi-Fi networks to find your location, accelerometer sensors to figure out how many steps you have taken, and a compass to show your direction. So you can figure out where you're going, how fast you're going, where you started from, and therefore where you are."

What makes Nektarios' system truly groundbreaking is that it will be trained by the user. "The first time you go to a new place, the system won't be able to direct you because it won't know anything about that place," he said. "But subsequently, it can remind you of the way. It will record the Wi-Fi signals, your walking speed and certain landmarks like an elevator and a water fountain. Then it will build a map. The more you train it, the more it will know about the building."

Nektarios is also working on a way for users to exchange information to improve their maps of a building. "I have part of a building mapped out and you have another part and we can exchange information so that we know more," he said.

American currency: impossible for the blind to distinguish

Nektarios' second project sprang from the problem caused by American currency. A one dollar bill is the same size and shape as a five, ten or twenty dollar bill – indistinguishable one from another for a blind person.

"If I buy coffee with a twenty dollar bill, the cashier will give me change consisting of a ten and several ones," Nektarios said. "I must ask the cashier which is which, and then I must fold each a different way or put them in a different pocket in my wallet. This isn't very good because I don't want to bother people asking them what the bills are, and you can't be sure they're going to be honest."

He continued, "When I want to buy something else, I have to remember which bill is in which pocket and how I folded it. To fix this problem, I want to be able to wave my mobile phone over a bill and have it tell me immediately what it is. When I have multiple bills, it should tell me I have a five on the left, two tens in the middle and a twenty on the right, efficiently and accurately."

Using Braille to send text messages on a touch screen phone

His third project involves creating a faster, easier way for the blind to send text messages with a touch screen phone. "When you are blind, a touch screen phone speaks to you when you touch the screen," Nektarios explained. "With an iPhone, you hover your hand over a letter and it will read it to you. But both of these take time."

Then an idea came to him. "I thought, most blind people know Braille. If you could use a touch screen as a typing pad for Braille, you could tap out the Braille pattern of each letter you want to type, which is faster and easier than using the touch keyboard," he said.

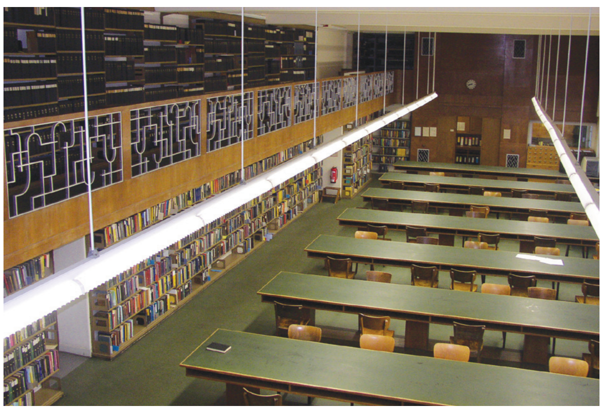
There is a fourth project that Nektarios is interested in but that he doesn't think he has time to complete. "I have a problem with matching clothes," he said. "I've never seen color, so I need something to detect color and tell me what goes with what, especially when an item has many colors or patterns."

Very appreciative of Courant's multitude and accessibility of experts

As he nears the completion of his five years at Courant, Nektarios was very complimentary of the Institute. "Courant is a very strong place," he stated emphatically. "We have some of the best professors here. The amount of people you can interact with is amazing; I'm not going to get this experience anywhere else. And we have very, very bright students here." ■

Warren Weaver Hall: A Retrospective by Brittany Shields

Richard Courant and then librarian Mary Carll stand in Warren Weaver Hall during its construction.



Göttingen Mathematical Institute Library (used by permission from the University of Göttingen).

Warren Weaver Hall opened its doors in 1965 as the home of the Courant Institute of Mathematical Sciences. Richard Courant, Cathleen Morawetz, and J.J. Stoker, then Institute Director, among other mathematicians, were greatly involved in the design of the new building. Central to their plans were not only classrooms and offices, but also the Institute's own library, lounge, and computer laboratory. Some of the features of the new building were similar to those of the Göttingen Mathematical Institute in Germany, which was built in 1929. Courant was the director of the Göttingen Mathematical Institute at the time and was instrumental in securing funds from the Rockefeller Foundation for the building's construction. The Göttingen Mathematical Institute was one of the first of its kind and included a comprehensive mathematics and mathematical physics library.

In 1933, just four years after the building opened, Courant was dismissed from the University of Göttingen by the Nazi government. After a year at the University of Cambridge, Courant emigrated to the United States and joined the mathematics faculty at New York University. Over the following three decades, Courant and the NYU mathematicians had a series of offices, including an abandoned hat factory, and eventually the group was split between 25 Waverly Place and 4-6 Washington Place.

In the early 1960s, funds were secured from the Alfred P. Sloan Foundation, the Ford Foundation, and the National Science Foundation for NYU to construct a building to house its Institute of Mathematical Sciences, which had grown to include researchers in mathematics, computing, and physics, among other sciences. Courant once again partook in the construction of a building devoted to the research and teaching of the mathematical sciences, this time on NYU's Washington Square campus. The design of Warren Weaver Hall included some features of the Göttingen Mathematical Institute, most predominantly a mathematics library. Warren Weaver Hall's twelfth floor library was designed to hold more than 10,000 volumes, 6,000 volumes of periodicals, and 3,000 reports. The library also incorporated study space for students, with a series of desks in nooks with floor-to-ceiling bay windows.

While discussing the needs of the new building, NYU mathematician Eleazer Bromberg described the collegial atmosphere of the Institute: "The character of this group is unique in a number of ways but particularly, I believe, in their approach to education and research as an organic unit and in their close collaboration and freedom from the aloof isolation which characterizes so many research mathematicians." To cultivate this sense of community, the thirteenth floor lounge, running the entire length of the building, was created as a space for faculty, students and staff to gather informally. Daily teas were served from 2:45pm to 4:15pm. Often, a group of mathematicians would gather around the piano for small concerts. By 1965, the Courant Institute employed 125 PhD scientists and mathematicians, 125 research assistants and fellows, and 100 technical and administrative staff members. The building contained 124,000 square feet of floor space, including several large lecture halls. The entire second floor was devoted to the IBM 7094 computer and its auxiliary equipment. Today, Warren Weaver Hall houses the Mathematics Department and half of the Computer Science Department. The other half of the Computer Science Department is located nearby in 715-719 Broadway. The Courant library is still regarded as one of the most comprehensive mathematics and computers science libraries in the nation. ■

— *Brittany Shields, Doctoral Candidate, History and Sociology of Science, University of Pennsylvania* Brittany is currently writing her doctoral dissertation which focuses on the history of the Courant Institute of Mathematical Sciences. bshields@sas.upenn.edu

Congratulations to our 2012 Student Prizes Winners!

Henning Biermann Award
Alex Rubinsteyn

Sandra Bleistein Prize
Y-Lan Boureau
Rebeca Salas-Boni

Janet Fabri Prize
Jay Chen
Daniel Wichs

Kurt O. Friedrichs Prize
Carl Gladish
Kenneth Ho

Harold Grad Memorial Prize
Lukas Koehler
Preyas Popat

Moses A. Greenfield Research Prize
Thomas Fai
Jens Jorgensen

Wilhelm T. Magnus Memorial Prize
Piriyadharshini Devendran
Sho Tanimoto

Bella Manel Prize
Katarina Bellova

Matthew Smosna Prize
Paul Gazzillo
Matthew Rathbone

Masters Student Thesis Prize
Andrea Rafael
Aminadav Recca
Diana Sordillo

Puzzle | SPRING 2012

Crowns of the Minotaur

by Dennis E. Shasha, Professor of Computer Science

Early in the life of the ferocious Minotaur (the fabled half-man half-bull), King Minos of Crete spoke to three of his youthful prisoners who were sharing a cell just outside Daedalus's Labyrinth. "You know that you will die if you fight the Minotaur unarmed. I propose therefore a chance at reprieve. I will separate and blindfold you and place either a red crown or a blue crown on each of your heads. I will choose the color in each case by flipping one of my lovely Cretian coins, which you can assume to be fair.

"I will then place you at three places evenly spaced around my lovely stadium: at the statues of Athena, Zeus and Neptune. You will be accompanied by a guard with instructions to kill you if you try to communicate with one another at any time during this protocol.

"Here is the proposition: at a signal from me, the guards will remove the blindfolds from each of you for just enough time for you to see one another. After that, each of you has ten seconds to tell your guard either 'blue', 'red' or 'pass' concerning the color of the crown on your head. After fifteen seconds, guards next to someone who guessed correctly will give a thumbs up. Those next to someone who guessed incorrectly will present a thumbs down. The rest will keep their hands flat. If you all say pass, you all go to the Minotaur. If all who don't pass are correct, then you all go free. If any of you who don't pass make a mistake, then again you all go to the Minotaur. If any of you tries to signal another, those still living go to the Minotaur."

Warm-up: What is the probability that the prisoners will win if they all bet randomly?

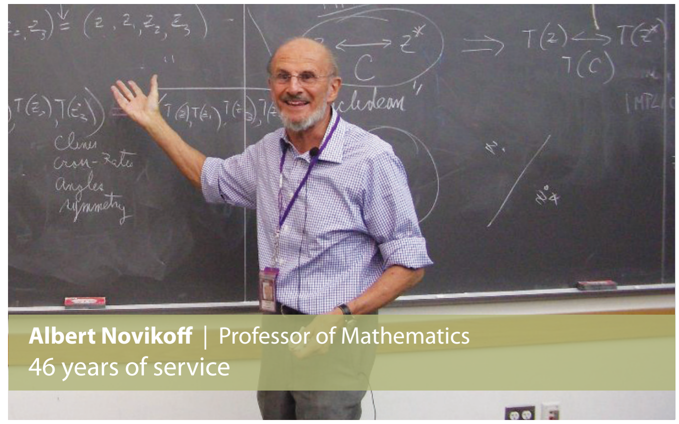
Answer: Only 1 in 8, since each has a probability of 1/2 of being wrong each time.

"Now, you may think that you have only a 1/2 chance of surviving, by simply designating one prisoner as the guesser. But if you are clever you will realize that you can design a strategy such that you have a 3/4 chance of winning. The strategy involves a rule that each of you must follow, but that requires no communication among you once you are in the stadium." What is this rule?

Suppose that King Minos had made the following offer, instead. "Suppose we change the rules so that each of you can 'bet' zero or more points about the color of the crown on your head. Each of you then wins or loses the number of points bet according to whether your answer is correct or not, with a 'pass' getting zero points. You will go free, if collectively, you win more points than you lose; otherwise, you all go to the Minotaur. Now, which game do you want to play?" Does the second game improve the prisoners' probability of survival? Why or why not?

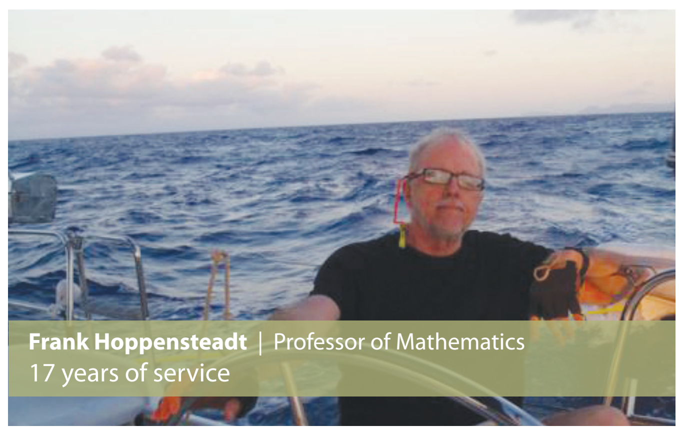
For the solution, email: courant.alumni@nyu.edu

Faculty Retirements



Albert Novikoff | Professor of Mathematics
46 years of service

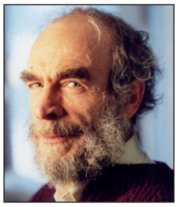
Albert B. J. Novkoff was born in New York city in 1927. He attended Bronx High School of Science and then in '46 Brown University (which then included visiting professors Feller, Bergmann, Zygmund, Loewner and many other Europeans). He received his Ph.D. from Stanford University on Orthogonal Polynomials under G. Szegö. Novikoff spent stints at Cornell Aeronautical Lab, John Hopkins (then Radiation Lab), two years at Berkeley, eight years at Stanford Research Institute, and finally found his place at NYU for the next 46 years (having arrived in 1964). He was recruited by Louis Nirenberg on recommendation by Peter D. Lax who claims credit for an assist. Novikoff specialized in teaching the mathematically challenged (a form of theater) and the Poincaré Half-Plane to unsuspecting upper class-people. ■



Frank Hoppensteadt | Professor of Mathematics
17 years of service

Frank Hoppensteadt is Emeritus Professor of the Courant Institute. Since he came to NYU in 1968, his mathematical research has been devoted to applied mathematics methods and to mathematical biology. His administrative career includes Chairman of Mathematics (Utah), Dean of the College of Natural Sciences (Michigan State), and Senior Vice-Provost (NYU). He holds several patents relating known circuits in the brain to nano-scale electronic circuits. He is presently living in Arizona where he continues work on design and development of nano-scale devices. His hobbies include sailing, yoga, music and grandchildren. ■

Faculty Honors



Mikhael Gromov

Mikhael Gromov was elected a Foreign Member of The Royal Society, UK, As stated in their citation: "Gromov ranks among the most deeply original mathematicians of our time, with contributions ranging from group theory, Riemannian and symplectic geometry, and the topology of partial differential relations, to his recent interest in the mathematics of biomolecular systems."

Marsha Berger

Marsha Berger was elected a fellow of the American Academy of Arts and Sciences. As stated in the NYU press release, "AAAS has elected as fellows and foreign honorary members the finest minds and most influential leaders from each generation."

Gérard Ben Arous

Gérard Ben Arous was elected a Fellow of the Institute of Mathematical Statistics. Fellowships are awarded to IMS members in honor of their "outstanding research and professional contributions."

Pierre Germain

Pierre Germain has received a Sloan Research Fellowship. The Fellowship recognizes early-career scientists who demonstrate "unique potential to make substantial contributions to their field." Germain studies nonlinear dispersive equations, which describe a wealth of physical phenomena, from quantum mechanics to general relativity to fluid mechanics.

Assaf Naor

Assaf Naor has received a Simons Foundation Fellowship in an inaugural class of 77. The Fellowship is given for "potential scientific impact" during a research leave, as based on the preceding five years.

XXVIIth Courant Lectures Presented by Daniel Spielman

Photo: Mathieu Asselin

Courant Director Gérard Ben Arous and Professor Dan Spielman at a reception in the Warren Weaver Hall Commons after this year's first Courant Lecture.

This year's Courant Lectures were presented by Daniel Spielman, Professor of Applied Mathematics and Computer Science at Yale. The first of the two lectures, for a general scientific audience, was given on March 30. It was titled "Algorithms, Graph Theory, and Laplacian Linear Equations," and told the story of "the development of shockingly fast algorithms for fundamental computational problems." As stated in the talk abstract: "The two main characters, systems of linear equations and graphs (also called networks), have been studied for centuries. They are brought together by the attempt to understand graphs through physical metaphors. Powerful graph analyses are achieved by viewing the links in a graph as resistors, springs, or rubber bands that meet at their vertices. To understand the resulting physical systems, one must solve systems of linear equations in Laplacian matrices." Prof. Spielman surveyed "recently developed nearly-linear time algorithms for solving linear equations in Laplacian matrices, along with ideas in graph theory that have been inspired by and that are employed inside these algorithms. These include algorithms for clustering vertices in graphs, a definition of what it means for one graph to approximate another, and fast algorithms for approximating graphs by trees and sparse graphs." Prof. Spielman gave the second, more specialized Courant lecture, on "Sparsification of Graphs and Approximation of Matrices," on April 2nd. ■

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Donations from friends and alumni of the Courant Institute greatly assist our educational and research missions.

Your donations to the Courant Annual Fund are more important than ever. This unrestricted income supports students and their conference travel, enhances the activities of our student clubs, and helps fund the cSplash and WinC outreach programs. The Annual Fund provides matching funds to secure grants from other sources, enables the Institute to invite distinguished speakers for both technical and public lectures, and assists in creating improved public spaces in both Warren Weaver Hall and the Broadway building.

Please join the Courant Director's Circle with a donation of $1,000 and above. This entitles you to join special events at the Institute, including a Circle only event in the fall, and the exclusive Director's Toast before the holiday party. Your donation will help support a truly extraordinary range of scientific and educational initiatives. ■

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

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