Courant Institute *of* Mathematical Sciences

Akshay Venkatesh Awarded 2007 Packard Fellowship and 2007–08 Salem Prize

Akshay Venkatesh, Associate Professor of Mathematics, is one of 20 researchers awarded a 2007 Packard Fellowship, established to strengthen university-based science and engineering programs by supporting unusually creative researchers early in their careers. Akshay's award is "to study number theory … and to develop techniques to study L-functions, which encode the behavior of prime numbers".

He has also been awarded the 2007–08 Salem Prize for his contributions to the analytic theory of automorphic forms and its applications to classical and modern problems in number theory, in particular his introduction of novel methods that combine analytic- and ergodic-theoretic techniques to resolve longstanding problems. The Salem Prize is awarded every year by the AMS to a young mathematician judged to have done outstanding work in the field of analysis.

Faculty: Recent Arrivals

Subhash Khot, Associate Professor of Computer Science. He works in theoretical computer science with an emphasis on computational complexity theory. His research includes probabilistically checkable proof systems, hardness of approximation results and lower bounds in restricted models of computation. He has been awarded a Sloan Foundation Fellowship, a Microsoft New Faculty Fellowship, and an NSF CAREER Award.

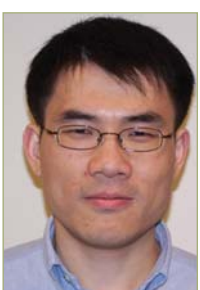**Rob Fergus, Assistant Professor of Computer Science**. His work is in the field of computer vision, with links to computer graphics and machine learning. Specific areas of interest include object recognition, computational photography and problems in low-level vision. He won the best paper award at the IEEE computer vision and pattern recognition conference in 2003, and in 2005 he co-taught a prize-winning short course on object recognition at the IEEE international conference on computer vision.

Fengbo Hang, Associate Professor of Mathematics. His research concerns nonlinear analysis and its applications to differential geometry and mathematical physics. He has worked on topology of Sobolev maps related to variational problems between manifolds, problems from conformal geometry and sharp inequalities in analysis and geometry. He was a recipient of the Sokol Postdoctoral Research

Fellowship and a Sloan Research Fellowship.

Petter Kolm, Clinical Associate Professor of Mathematics and Deputy Director of the Mathematics in Finance M.S. Program. His interests include delegated portfolio management, financial econometrics, quantitative trading strategies, risk management, and optimal portfolio strategies. He coauthored the books *Financial Modeling of the Equity Market: From CAPM to Cointegration* (Wiley, 2006), *Trends in Quantitative Finance* (CFA Research Institute, 2006), and *Robust Portfolio Management and Optimization* (Wiley, 2007).

Jean–Claude Franchitti, Clinical Associate Professor of Computer Science. His interests include database systems and software engineering, with an emphasis on large scale software architectures and business solutions. He has over 25 years of experience in the industry, having held executive positions in large US-based corporations and served on several industry standards committees, and has conducted research as part of several NSF and DARPA funded research programs.

Holiday Puzzle 2007 – Polish Hand Magic
By Dennis Shasha, Professor of Computer Science

I don't really know the origin of this trick but a smart and elegant Polish woman taught it to me, whence the title.

In the process of learning multiplication by single digits, children have an easy time provided one digit is less than 5. They have much more trouble when both are 5 or over. That is what Polish Hand Magic addresses.

Let me explain the trick with a few examples. Suppose that you want to multiply 9 by 7. You represent 9 (= 5 + 4) by ||||., that is four fingers up and the thumb down. You represent the 7 (= 5 + 2) by ||..., that is two fingers up and three fingers down. The total number of fingers that are up is 6. That becomes six tens. The product of the fingers that are down is 3 x 1 = 3. So the answer is 63.

Here is another example: 8 x 6. 8 becomes |||.. and 6 becomes |....; 4 fingers are up in total and the product of the down fingers is 2 x 4 = 8. So the answer is 48.

This even works for extreme cases such as 10 x 5. 10 becomes ||||| and 5 becomes .....; we have 5 fingers up in total and the product of the down fingers is 0 x 5 = 0. So the answer is 50.

Another interesting case is 6 x 7. 6 becomes |.... and 7 become ||...; three fingers are up and the product is 4 x 3 = 12. So we get 30 + 12 = 42.

The general method follows.
Step 1. Take each digit, subtract 5, and put up that many fingers.
Step 2. Sum the fingers that are up. That's the 10s place.
Step 3. Multiply the fingers that are down. That's the 1s place; there may be a carry into the 10s place.

It seems magical I know. You might teach it as magic to your child, but can you yourself explain what's going on?

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

This puzzle is adapted from *The Puzzler's Elusion: A Tale of Fraud, Pursuit, and the Art of Logic* by Dennis Shasha, 2006. His latest puzzle book *Puzzles for Programmers and Pros* was published this past spring.

PAUL GARABEDIAN: AT 80 YEARS YOUNG, IT'S FULL STEAM AHEAD
By M.L. Ball

When the rest of us reach our 80th year, we should all hope to be as vibrant and full of bounce as Paul R. Garabedian. A highly accomplished professor of mathematics, at the Courant Institute since 1959, and now Director of the Division of Computational Fluid Dynamics, Dr. Garabedian dives into each day's work with the passion of a 20-something.

While most of his contemporaries have long since retired, he is currently teaching a course in complex variables this fall and sees no reason to stop. Even he admits that it's unusual at his age to be working with a brain that's mathematically still incisive.

Not only is Prof. Garabedian still working but he is currently a groundbreaking leader in the field of magnetic fusion. He spoke in Toki, Japan on October 18 at the 16th International Stellerator Workshop, the nature of which he says is unusual because it's in a field of physics, using computational science.

> In magnetic fusion, hot deuterium and tritium ions are combined to form helium and release neutrons intended to provide a commercial source of energy. The color map of the hydrogen plasma in the figure displays a symmetry property that enhances confinement. Twelve only moderately-twisted coils generate a magnetic field designed to keep the plasma in stable equilibrium separated from material walls.
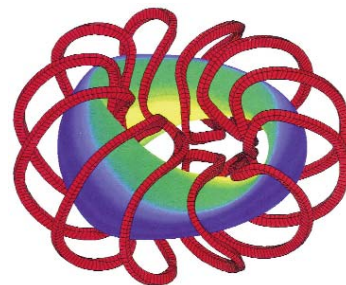
A quasisymmetric stellarator. From Romeo Alexander and Paul R. Garabedian, "Choice of coils for a fusion reactor." Proceedings of the National Academy of Sciences, July 24, 2007, 104, 12250-12252.

Prof. Garabedian began his career in the late 1950's working for the U.S. Navy with a research grant for naval hydrodynamics. The Cold War was in full swing and had everyone on edge. It was while he was working for the Navy that the Atomic Energy Commission became interested in magnetic fusion reactors, which involved similar mathematics but a different type of security clearance.

"Through fusion," Prof. Garabedian says, "scientists were trying to design a nuclear reactor that would be a commercially viable source of energy."

In 1958, the U.S. Government declassified the magnetic fusion research and Prof. Garabedian felt that this was something he could work on. He taught electromagnetic theory as a math course and says now that he learned the material by teaching it, picking up physics as he went along.

Returning this fall to the field in which he earned his Ph.D., Prof. Garabedian is teaching a graduate course in complex variables comprised of 35 students. The class has both master's candidates and undergrads. He likes to teach eager faces who want to learn, he says.

"The agony and the ecstasy" is how Prof. Garabedian describes those moments when great ideas have come to him. In his younger years, these epiphanies might happen several times a year; as he's gotten older, maybe once a year. "These good ideas have come from a lot of hard work; they didn't come from nowhere," he explains. "I'm a hard worker, not a genius."

Speaking of working hard, it's while describing his present work that Prof. Garabedian becomes positively giddy. The cause of the excitement? "I'm finding that I have to prove myself again – I'm treated as a newcomer, not as an old duffer, which keeps me on my toes!" It's a lot of fun and he's having a good time, and according to him, "If I rested on my laurels, I'd fall asleep."

Here's hoping the rest of us can be as awake as Paul. Garabedian, a true *professeur extraordinaire*.

HOW CAN ONE MAN IMPROVE THE LIVES OF MILLIONS?
JUST ASK LAKSHMINARAYANAN SUBRAMANIAN

By M.L. Ball

How many of us truly have a chance to change the world? Professor Lakshminarayanan Subramanian does. What's more, he has the vision, the passion, the commitment to make it happen…and he's right here at Courant.

The first thing you notice about Lakshminarayanan (whom everyone calls Lakshmi) is his energy, which seems endless. Here's a peek into his schedule: an avid musician, Lakshmi attends two to three concerts a week. This fall, he's teaching a course entitled "Information and Communication Technologies (ICTs) for Developing Regions." He spent last summer in four African countries (Ghana, Kenya, Tanzania, and Uganda) and much of this summer in India, visiting hospitals and microfinance institutions in rural regions to observe the state of rural healthcare delivery and financial services. He's currently conducting research in three areas: networks, distributed systems, and security. He's passionate about the area of "technologies for developing countries" and is very interested in applying his research expertise to address pressing problems in underdeveloped regions around the world. On top of all this, he's training for a marathon!

Lakshmi's education began in India where he did his undergraduate work at the Indian Institute of Technology Madras, specializing in Computer Science; he then earned his Master's and Ph.D. at the University of California at Berkeley. With a sparkle in his eye, Lakshmi explains, "Berkeley was a phenomenal place but New York is even better. In New York, there's life all around you all the time, which reminds me of India. And everything is close by."

Now in his second year as an NYU faculty member at Courant, Lakshmi is as excited about his move to the East Coast as ever. "Teaching at the Courant Institute is a very humbling experience," he says. "All the time, you see legendary people who've had amazing achievements. During my job interview, I unknowingly spoke with two Abel Prize winners in very casual settings (elevator and lounge): Peter Lax and Raghu Varadhan. One of them even gave me interviewing tips. That was mindblowing."

Currently, his research interests are twofold: security issues in large scale networks and systems, and networking and systems technologies for the developing world. It is this second area that has the potential to impact millions around the world, and which is at the center of the course he is teaching.

In class and in his research, what Lakshmi asks his students and himself is the same: "How can you apply computer science research to address important problems in developing countries, specifically in the areas of healthcare, education, financial services, and supply chain?"

In his quest for a tangible, real-world answer, Lakshmi has recently created CATER (Cost Effective Appropriate Technologies for Emerging Regions), a lab within NYU comprised of a group of multi-disciplinary researchers from Courant, the NYU School of Medicine, the Wagner School of Public Policy, external collaborators at UC Berkeley and the University of Washington, and researchers in India. This project has been his focus for the past two years, the first year of which was spent with Intel Research at Berkeley working on TIER (Technology and Infrastructure for Emerging Regions). A multidisciplinary project whose aim is to make technology accessible to low income/low literacy regions around the world, TIER develops hardware, software, and infrastructure specifically designed to meet the physical, political, and economic realities of those regions. "Some of these low income regions are even in the U.S.," Lakshmi says.

It was while working on TIER that Lakshmi developed WiLDNet (Wi-Fi Long Distance Networks), which uses the same WiFi cards as in a laptop to create a point-to-point WiFi link that can deliver tens of megabytes of bandwidth over 100 kilometers, all for the low cost of $1000 per link. Recently, using WiLDNet, the TIER team was able to break the world record for the longest wireless link spanning 382 kms delivering 6 Mbps.

WiLDNet is currently being deployed in several developing countries in Asia and Africa. In particular, the WiLDNet network for the Aravind Eye Hospital in Southern India, one of the world's largest eye facilities which sees 2 million patients a year, connects nine rural vision centers in rural India with its main hospital. This network currently provides wireless telemedicine services to over 50,000 patients per year, and was publicized by the BBC in its technology section on October 5th.

"This experimental network will enable rural residents to have video consultations with doctors at a local vision center, eliminating the need for them to travel miles and miles to a hospital for routine eye care. And each visit costs just 25 cents," Lakshmi explains. The network has been so successful that the President of India wants to expand it to 50 eye clinics in hopes of serving 500,000 patients per year. TIER is building a similar network in Ghana.

According to Lakshmi, "This type of telemedicine network can potentially revolutionize health care delivery around the world."

"Not only that," he adds, "this program has the potential to reduce corruption; extend financial services to underserved populations; provide better education through distance learning; and deliver better health care through telemedicine, teleconsultation, and most importantly, ongoing medical education for health care workers, especially those working in remote, rural areas. With today's technology, you can even send medical records through cell phones." Lakshmi is currently working with several experts at the NYU School of Medicine to tailor WiLD networks to provide low-cost continuing medical education to healthworkers.

Apart from wireless networks, Lakshmi and his students are also working on a variety of topics pertaining to developing regions, including: intermittent distributed systems (operating cafes and ATMs in villages over intermittent links), cell phone-based information services (for microfinance and health records), low cost paper watermarking, and image processing problems relating to diabetic retinopathy detection (along with Courant Professor Yann Lecun).

According to Lakshmi, low-cost cell phone-based technologies can potentially play a huge part in the distribution of microfinance. The pioneer of this highly successful field is Muhammad Yunus, winner of the 2006 Nobel Peace Prize along with Grameen Bank, which he founded. A Bangladeshi banker, economist, and former professor of economics, Yunus has successfully applied the concept of microcredit – the extension of small loans to entrepreneurs too poor to qualify for traditional bank loans – to lift millions out of poverty. Two of the biggest problems with microfinance today are high transaction costs for banks to recover repayments and corruption due to lack of accounting. It is these two problems that Lakshmi believes appropriate technology can solve, and he is currently working with banks and financial institutions in India to potentially roll out his solutions.

When asked how he feels about his research, especially in the area of creating revolutionary technologies for developing countries, Lakshmi responds without hesitation. "I am passionate about my research. I don't just enjoy it, I am passionate about it. As all good researchers should be!"

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Thomas Bringley Wins 2007 SIAM Student Paper Prize

Thomas Bringley, a Ph.D. student in mathematics at Courant, has won a 2007 SIAM Student Paper Prize for his paper "Validation of a Simple Method for representing Spheres and Slender Bodies in an Immersed Boundary Method for Stokes Flow on an Unbounded Domain," co-authored with Charlie Peskin. The prize competition covers all fields in the SIAM domain (from applied mathematics to computing); at most three awards are given annually. Thomas will have the opportunity to present his work at the 2008 SIAM Annual Meeting in San Diego.

Computer Science Students Showcase Their Great Ideas

By M.L. Ball

On May 3rd, the NYU Computer Science Department held its annual Spring Showcase on the 13th Floor of Warren Weaver Hall. And what a showcase it was! Spanning two sessions, a total of more than 50 projects displayed concepts learned in eight undergraduate and graduate Spring semester computer science courses, high-lighting the students' creativity, talent, and hard work. For more details on the projects, visit http://www.cs.nyu.edu/~barrett/showcase/index.txt.

The Undergraduate Courses Were:

Game Programming for the Web taught by Sana' Odeh. Students created their own original computer games. Some of the most intriguing were: (a) Stratego: denizens of the Red Country engage in a fierce battle with their bitter enemies from the Blue Country. Guerilla warfare at its finest. (b) Whack-A-Rabbit: players relive their child-hood when they went to carnivals and whacked moles. Using rabbits as the victims, the game draws inspiration from Monty Python's The Holy Grail. (c) Zomg Zombies WTF, an adventure game featuring ninjas, zombies, and of course, cupcakes.

Data Structures taught by Sam Marateck. The honors stu-dents in this course produced two Maze Solving projects.

Intro to Computer Science taught by Sam Marateck. Here the honors students developed GUI for Craps and the Game of Life.

Software Engineering taught by Clark Barrett. Club Management System was a very clever way to manage school clubs, and Trippin' 07 was a brilliant modern take on the vacation photo album/journal theme. The third project was Buck Rodgers Turn-based Strategy Game.

And At The Graduate Level:

What if a Computer Lies? taught by Lakshmi Subramanian. These twelve projects concerned computer security and ranged broadly from Speckles: Low-cost Paper Watermarking, to Friendstore: Distributed backup using Social Networks, to Analyzing the Effectiveness of Snort.

Intro to Motion Capture taught by Chris Bregler. Nine movie demos illustrated the art of motion capture, includ-ing fascinating footage of moving bodies.

Software Engineering taught by J.C. Franchitti. Four intricate, very intelligent projects emerged from this course: Online Shopping Cart, Automated Teller Machine, FamilyNet-Extending Online Social Network, and Online Banking System.

Information Technology Projects taught by Arthur Goldberg. This is the capstone project course for the MS in IS degree, which requires working with an outside organiza-tion, usually in a team project. The activities ranged from a project with Alvin Ailey Dance Theater to a project with one person serving as the intermediary between NY State and a development team in India.

Take A Step Back in Time

It is with sadness that we report the passing of Malcolm Harrison, one of the seven founding faculty members of the Computer Science Department, which began in 1969. Malcolm died this past May at the age of seventy. His wife Alison predeceased him by several years. He is survived by three children and several grandchildren.

Malcolm grew up in England, and came to the US to do a postdoc at MIT. He joined NYU in 1964 as a research scientist, becoming a faculty member in 1967. He spent his whole career at NYU, retiring in 1998. He was an important player in most of the major systems building projects here over a span of more than three decades. This began with his work on the Sharer Operating System, a time sharing operating system for the CDC 6600, a supercomputer of its time. He was the creator of the BALM programming language, an extensible list processing language, which was later used for the first implementation of the SETL programming language. It is also remembered as a remarkable and lucid teaching tool: for over a decade, students learned compiler construction from the text of the BALM compiler, itself written in BALM. Subsequently, he was intimately involved in the UltraComputer project and then was the lead designer on the Griffin project. He also maintained an active interest in AI algorithms and Theorem Proving methods in particular.

In his spare time he was a passionate sailor and trout fisherman, and he likened using worms to fish for trout to using a hammer as a screwdriver. Malcolm's children remember him as a person that believed conventional wisdom was something to be considered rather than accepted, and he even won his NYC darts teams' cham-pionship using ten-penny nails. He challenged all those around him with good humor combined with a rare intellect, and will be missed in several communities.

Courant Awarded $2.5M NSF PIRE

Courant has been awarded a five year Partnerships for International Research and Education (PIRE) Grant for "Percolative and Disordered Systems" in the selected areas of Probability Theory and Statistical Physics. Its goal is to promote the development of a globally-engaged, U.S. scientific and engineering workforce.

This will be achieved through an international collaborative education and research program to train U.S. students, postdoctoral fellows and faculty from various backgrounds. In particular, Courant PIRE postdoctoral and predoctoral fellows will be expected to spend at least one semester abroad with joint mentoring by one of the international collaborators and a Courant faculty member. Other students and postdocs will be encouraged to collaborate internationally via shorter visits and by participating in seasonal schools.

The collaborating institutions are Instituto Nacional de Matematica Pura e Aplicada (IMPA) of Rio de Janeiro, and the Centrum voor Wiskunde en Informatica (CWI) of Amsterdam. The Principal Investigator is Chuck Newman and the NYU co-PI's are Gerard Ben Arous, Scott Sheffield, Dan Stein and Raghu Varadhan.

For more information please go to www.cims.nyu.edu/pire.

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