Mathematics People

Candès Receives NSF Waterman Award

EMMANUEL CANDÈS of the California Institute of Technology has been selected to receive the National Science Board's prestigious Alan T. Waterman Award. The board cited Candès' development of new mathematical tools that allow efficient digital representation of wave signals, together with his discovery of new methods to translate analog data into a cleaner, tighter digital form—work that promises to improve the digital processing of signals in a vast array of modern technologies.

The annual Waterman Award recognizes an outstanding young researcher in any field of science or engineering supported by the National Science Foundation. Candidates may not be more than thirty-five years old, or seven years beyond receiving a doctorate. In addition to a medal, the awardee receives a grant of US$500,000 over a three-year period for scientific research or advanced study at the institution of the recipient's choice.

Previous mathematical scientists receiving the Waterman Award are Vahid Tarokh (2001), Gang Tian (1994), Herbert Edelsbrunner (1991), Edward Witten (1986), Harvey M. Friedman (1984), William P. Thurston (1979), and Charles L. Fefferman (1976).

The Work of Emmanuel Candès

The Notices *asked David Donoho of Stanford University to comment on the work of Candès. Donoho's response follows.*

Emmanuel Candès applies harmonic analysis to scientific and technical signal processing, a field of central importance in our modern signals-drenched world, underpinning fields as diverse as cosmology, genomics, medical imaging, biometrics, oil exploration, and digital communications.

While some signal processing simply involves moving information around, many important applications deploy nontrivial transformations to solve difficult tasks with surprising elegance. A poster child for a previous generation was the Fast Fourier Transform (FFT), which now accelerates everything from secure encryption to speech recognition, image compression, medical imaging, and image deblurring. The FFT revolution combined an insight about technology and a mathematical contribution—the insight being that convolutions and correlations were of fundamental importance, and the contribution being that such operations could be radically sped up by exploiting dyadic divide-and-conquer in the Fourier domain.

All mathematicians recognize Fourier analysis as one of the great achievements of human intellect. Far fewer know that harmonic analysis is a broad subject with a powerful toolkit offering "atoms" and "molecules" with prescribed properties, for the purpose of better representing objects or operators. Examples include wavelet analysis and Gabor analysis, in which the atoms are, respectively, time-scale atoms and time-frequency atoms. Such tools offer new ways to break down, transform, and re-express objects and operations. In fact they are not merely new, but for certain model classes of signals they each are optimal—just the right way to transform and represent certain kinds of signals. Moreover, formal statements of optimality in mathematical models correspond to actual advantages in practical implementations. Thus, wavelet transforms offer a better framework for compressing images than the Fourier approach, which was the basis of JPEG, and form the basis for the new compression standard JPEG-2000; and wavelets are responsible for the success of various fast computer graphics rendering algorithms—wavelet radiosity.

Emmanuel Candès' work over the last ten years has developed new systems of analysis that go beyond wavelets and has applied them to important scientific and technical signal processing problems. I mention four examples. (In many cases, Candès worked with collaborators, but space restrictions force us to omit details.)

Ridgelets. These provide a multiscale system for representing multivariate functions, consisting of objects which, unlike wavelets, are highly directional—infinitely long in one direction and multiscale in the other direction. They are useful for representing functions with singularities along lines and for representing operators, like the Radon transform, which integrate along lines. Candès established the basic results about this system in his thesis and applied them to image denoising and limited-angle tomography, a fundamental operation throughout medical imaging and applied physics.

Curvelets. This system again consists of objects that are highly directional, with width scaling parabolically in the length of the support. Prefigured by work of Charles Fefferman, Andreas Seeger, Elias Stein, Christopher Sogge, and especially Hart Smith, Candès' work created a computationally useful system, a tight frame, and a concrete algorithm, and showed that curvelets do a theoretically optimal job of compressing objects with edges—much better than wavelets or Fourier methods. Candès also worked to show that curvelets in principle offer an unheard-of efficiency in solving the wave equation with rough initial wavefields.

Chirplets. Chirplets are a multiscale system with time-varying frequency content, having elements at all different base frequencies, durations, and chirp rates. Candès worked to create an adaptive basis of chirplets, to show that they do a theoretically optimal job of representing chirping signals with smoothly-changing frequency. They are much better than Gabor systems.

Noiselets. The idea is to project the signal onto random elements. Although no "real" signal is efficiently representable by random elements, paradoxically by making measurements using only a small subset of a random basis one gets enough information to approximately reconstruct a real signal. While the measurements are linear, the reconstruction must be nonlinear, involving convex optimization. Potential applications include rapid medical imaging and much faster analog-digital converters.

In each case, Candès considered a fundamental signal type, developed a fundamental aspect of the "architecture of information" for that signal type, and used that architecture to give an optimal solution to a model problem of considerable applied interest. His work shows how applied mathematics can serve as a central component of the information sciences (instead of its traditional role supporting the physical sciences).

Biographical Sketch

A professor of applied and computational mathematics at Caltech, Candès studied in his native France before receiving a doctorate in mathematics and computer science at Stanford University in 1998. He has received numerous awards for his work, including the Vasil Popov Prize in approximation theory, the Department of Energy Young Investigator Award, the James H. Wilkinson Prize in numerical analysis and scientific computing, and the Best Paper Award of the European Association for Signal, Speech and Image Processing. He was selected as an Alfred P. Sloan Research Fellow in 2001.

Emmanuel Candès wrote a WHAT IS... ? column, "WHAT IS... a Curvelet?", which appeared in the December 2003 issue of the *Notices*.

—Allyn Jackson

Young Scholars' Competition Prizes Awarded at Gödel Centenary

Three mathematicians were awarded prizes in the Young Scholars' Competition held at the Gödel Centenary. JUSTIN MOORE of Boise State University was awarded the first prize of 20,000 euros (approximately US$25,000) for his paper, "The Continuum and Aleph-2"; MARK VAN ATTEN of the Institute for the History and Philosophy of Science and Technology, Paris, received the second prize of 5,000 euros (approximately US$6,000) for his paper "Gödel and German Idealism"; and ELI BEN-SASSON of the Israel Institute of Technology was awarded the third prize of 5,000 euros for his paper "Searching for the Conditional Answer to Gödel's Question".

"Horizons of Truth: Logics, Foundations of Mathematics, and the Quest for Understanding the Nature of Knowledge", the Gödel Centenary Symposium, was held April 27–29, 2006, in Vienna, Austria, to honor the 100th birthday of Kurt Gödel.

—Elaine Kehoe

Sherratt Awarded Adams Prize

JONATHAN SHERRATT of the Heriot-Watt School of Mathematical and Computer Sciences has been awarded the 2006 Adams Prize by the University of Cambridge. The selected topic for the prize was mathematical biology.

The Adams Prize is awarded each year by the Faculty of Mathematics and St. John's College to a young researcher based in the United Kingdom who is doing first-class international research in the mathematical sciences. The prize is named after the mathematician John Couch Adams and was endowed by members of St. John's College. It is currently worth £13,000 (approximately US$24,000), of which one-third is awarded to the prizewinner on announcement of the prize; one-third is provided to the prizewinner's institution (for research expenses of the prizewinner); and one-third is awarded to the prizewinner on acceptance for publication in an internationally recognized journal of a substantial (normally at least twenty-five printed pages) original survey article of which the prizewinner is an author.

—From a University of Cambridge announcement

Putnam Prizes Awarded

The winners of the sixty-sixth William Lowell Putnam Mathematical Competition have been announced. The Putnam Competition is administered by the Mathematical Association of America and consists of an examination containing mathematical problems that are designed to test

both originality and technical competence. Prizes are awarded to both individuals and teams.

The six highest ranking individuals, listed in alphabetical order, were OLEG I. GOLBERG, Massachusetts Institute of Technology; MATTHEW M. INCE, Massachusetts Institute of Technology; DANIEL M. KANE, Massachusetts Institute of Technology; RICKY I. LIU, Harvard University; TIANKAI LIU, Harvard University; and AARON C. PIXTON, Princeton University.

Institutions with at least three registered participants obtain a team ranking in the competition based on the rankings of three designated individual participants. The five top-ranked teams (with team members listed in alphabetical order) were: Harvard University (Tiankai Liu, Alison B. Miller, Tong Zhang); Princeton University (Ana Caraiani, Andrei Negut, Aaron C. Pixton); Duke University (Nikifor C. Bliznashki, Jason Ferguson, Lingren Zhang); Massachusetts Institute of Technology (Timothy G. Abbott, Vladimir Barzov, Daniel M. Kane); and University of Waterloo (Olena Bormashenko, Ralph Furmaniak, Xiannan Li).

The top five individuals in the competition received cash awards of US$2,500; the next ten received US$1,000. The first-place team was awarded US$25,000, with each team member receiving US$1,000. The team awards for second place were US$20,000 and US$800; for third place, US$15,000 and US$600; for fourth place, US$10,000 and US$400; and for fifth place, US$5,000 and US$200.

The Elizabeth Lowell Putnam Prize is awarded periodically to a woman whose participation in the Putnam Competition is deemed particularly meritorious. In the recent competition, this prize went to ALISON B. MILLER of Harvard University. The prize carries a cash award of US$1,000.

—Elaine Kehoe

European Mathematical Society Article Competition

The European Mathematical Society (EMS), through its committee for Raising Public Awareness of Mathematics (RPA), has announced the winners of its article competition. Articles appearing in newspapers or other general-interest magazines in the authors' home countries were eligible.

NUNO CRATO of Universidade Técnica de Lisboa, Portugal, was awarded first prize for his three-part article "Unbreakable Cybersecrets", published in the Portuguese weekly newspaper *Expresso* in 2001. His articles are available in Portuguese and English at the website `http://pascal.iseg.utl.pt/~ncrato/EMS/`. F. THOMAS BRUSS of Université Libre de Bruxelles, Belgium, was awarded second prize for his article "Playing a Trick on Uncertainty", published in the magazine *Spektrum der Wissenschaft* in 2000, and for a similar article published in the daily German newspaper *Die Welt* in 2001. His article is available in German and English at the website `http://www.ulb.ac.be/facs/sciences/math/perso/bruss.html`. SAVA GROZDEV, IVAN DERZHANSKI, and EVGENIA SENDOVA of the Union of Bulgarian Mathematicians were awarded third prize for their article "For Those Who Think Mathematics Dreary", published in the Bulgarian daily newspaper *Dnevnik* in 2001. Their article is available in Bulgarian and English at the website `http://www.math.bas.bg/ml/iad/dremat/dmathen.html`.

—From International Mathematical Union email newsletter

AMS Menger Awards at the 2006 ISEF

The 2006 Intel International Science and Engineering Fair (ISEF) was held May 7–13, 2006, in Indianapolis, Indiana. This was the fifty-seventh year of the ISEF competition. More than fifteen hundred ninth to twelfth graders from forty-seven countries qualified to compete for US$4 million in scholarships and prizes by winning top honors in local, regional, and state fairs in the United States or national science fairs abroad. The AMS participated by presenting special awards at the ISEF. Prizes awarded by the AMS included cash, certificates, books, and tote bags.

For the AMS this was the nineteenth year of participation in the ISEF and the seventeenth year of presentation of the Karl Menger Awards. AMS awards were presented to one first-place, two second-place, four third-place projects, and honorable mention to three others.

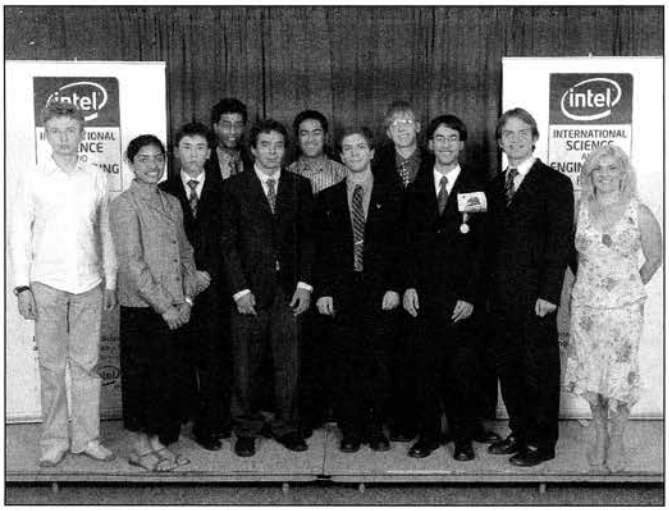
The AMS Menger Committee served as the AMS Special Award Panel of judges. The members of the AMS Menger Committee are Gisèle Ruiz Goldstein (chair) (University of Memphis), Dmitry Fuchs (University of California, Davis), and Tatiana Shubin (San Jose State University). The committee reviewed sixty mathematics projects and selected ten winners.

The winners are:

First-Place Award (US$1,000): "The Solution of the Dirichlet Problem with Rational Boundary Data", MICHAEL ANTHONY VISCARDI, 17, Josan Academy, San Diego, California.

Second-Place Award (US$500): "A Fully Combinatorial Proof of the Chan-Robbins-Yuen Theorem", DANIEL ABRAHAM LITT, 17, Orange High School, Pepper Pike, Ohio; "On the Reducibility of Cyclotomic Polynomials Over Finite Fields", BRETT ALEXANDER HARRISON, 17, Half Hollow Hills High School West, Dix Hills New York.

Third-Place Award (US$250): "Novel Method of Computing Jacobi Symbols for Mersenne Numbers: Allowing for Generation of S Values for the Lucas-Lehmer Primality Test", ANARGHYA A. VARDHANA, 17, Jesuit High School, Portland, Oregon; "On Embeddability of Cubic Graphs with Rotations in the Torus", GLEB A. POGUDIN, 15, Gymnasium 6, Novosibirsk, Russian Federation; "Character Sums and Ramsey Properties of Generalized Paley Graphs", NICHOLAS MICHAEL WAGE, 17, Appleton East High School, Appleton, Wisconsin; "A Finiteness Property for Integral Points in a Family of Conics", SOHAN VENKAT MIKKILINENI, 17, Detroit Country Day School, Beverly Hills, Michigan.



Menger Awards group photo: (left to right) Gleb Pogudin, Anarghya Vardhana, Bakhytzhan Biazhanov, Sohan Mikkilineni, Manuel Rivera-Morales, Meelap Shah, Daniel Litt, Nicholas Wage, Michael Viscardi, Brett Harrison, and committee chair Gisèle Ruiz Goldstein.

Honorable Mention Awards: "Extended Fault Tolerance of Hyper-star Graphs", MEELAP VIJAY SHAH, 17, Stoney Creek High School, Rochester Hills, Michigan; "Reinterpretation of the Theory of Graph Minors and the Study of a Special Case of Hadwiger's Conjecture", MANUEL LUIS RIVERA-MORALES, 17, Colegio San Ignacio de Loyola, San Juan, Puerto Rico; "Criteria of Realization of Bouquets on the Plane and Tore", BAKHYTZHAN BAIZHANOV, 17, Aktobe Kazakh-Turkish High School, Aktobe, Kazakhstan.

The AMS's participation in the Intel-ISEF is supported in part by income from the Karl Menger Fund, which was established by the family of the late Karl Menger. For more information about this program or to make contributions to the fund, contact the AMS Development Office, 201 Charles Street, Providence, RI 02904-2294, send email to `development@ams.org`, or telephone 401-455-4111.

—Gisèle Ruiz Goldstein, University of Memphis

Ford Foundation Diversity Fellowships Awarded

The names of the recipients of the Ford Foundation Diversity Fellowships for 2005 have been announced. The Ford Foundation's predoctoral, dissertation, and postdoctoral fellowship programs seek to increase the presence of underrepresented minorities on college faculties. Awardees later serve as role models and mentors for a new generation of scholars. ROBIN TODD WILSON of the University of California, Davis, was awarded a Dissertation Fellowship. He is a student in the field of topology.

—From a Ford Foundation announcement

Mega Math Challenge 2006

The Moody's Foundation and the Society for Industrial and Applied Mathematics (SIAM) have announced the awarding of US$60,000 in scholarships to teams of high school students in the Mega Math Challenge, a competition in applied mathematics that focuses on real-world problems. The problem for the competition was "Solving the Social Security Stalemate", and it required students to "develop a mathematical analysis of the issues and present one or more approaches that would guarantee the integrity of the system for at least 75 years."

Staples High School in Westport, Connecticut, was awarded the Summa Cum Laude team prize of US$20,000. The team members were MILES LUBIN, ELIZABETH MARSHMAN, VIKAS MURALI, and ANDREW TSCHIRHART. Immaculata High School in Somerville, New Jersey, was awarded the Magna Cum Laude team prize of US$15,000. The team members were CHRISTOPHER FAJARDO, MARY GERMINO, ROBERT LEE OWEN, WILLIAM PUGH, and MATTHEW TOM WOLVERTON. Herricks High School in New Hyde Park, New York, received the Cum Laude team prize of US$10,000. The team members were AMULYA BHAGAT, AMOL JAIN YAAGNIK KOSURI, and SAM YOON. Other team prizes went to Great Neck North High School, Great Neck, New York; Manalapan High School, Manalapan, New Jersey; and High Technology High School, Lincroft, New Jersey. The top six solutions are available at the website `http://m3challenge.siam.org`.

—From a Moody's Foundation/SIAM announcement

Royal Society of London Elections

Five mathematical scientists are among those elected as new fellows and foreign members of the Royal Society of London for 2006. They are: PETER J. DONNELLY, University of Oxford, for contributions to population genetics and other areas of probability and statistics; RAYMOND W. OGDEN, University of Glasgow, for contributions to the nonlinear theory of elasticity and its applications; NICHOLAS I. SHEPHERD-BARRON, University of Cambridge, for contributions to algebraic geometry and classification of higher dimensional varieties; JERROLD E. MARSDEN, California Institute of Technology, for contributions to a wide range of fields, including Hamiltonian systems; and ALAN G. WILSON, Director General of Higher Education in the United Kingdom, for research on cities and regions through mathematical and computer models.

—From a Royal Society announcement

Correction

A review of Alex Kasman's book *Reality Conditions* appeared in the August 2006 issue of the *Notices*. The summary information about the book that appeared at the beginning of the review gave the number of pages in the book as 512; in fact, the book has 264 pages.

—Allyn Jackson