ANNUAL
FALL 2014

Institute for Pure and Applied Mathematics
a National Science Foundation Math Institute
at the University of California, Los Angeles

NEWSLETTER

MACHINE LEARNING EXPERT BENEFITS FROM IPAM CONNECTIONS

Yann LeCun calls it the "secret sauce" that makes UCLA's Institute for Pure and Applied Mathematics so successful. "IPAM doesn't see math as an isolated ivory tower, but rather as interacting with other fields that have a wide range of applications and impacts on society," LeCun says.

IPAM's ability to bring together mathematicians and experts in fields with complex mathematical challenges to solve specific problems is what led LeCun, a professor of computer science at NYU's Courant Institute and, since late 2013, director of artificial intelligence (AI) research at Facebook, to accept an invitation to join IPAM's Science Advisory Board in 2008. LeCun is at the forefront of research into machine learning – a topic of growing excitement with AI applications that include computer vision, speech recognition and natural language understanding, as well as applications to biology, astrophysics and social sciences. The topic has become a major area of focus for IPAM, which has held a series of related programs and workshops organized by LeCun in recent years.

Machine learning refers to the ability of machines to evolve from experience as opposed to being exclusively programmed. In particular, LeCun is interested in deep learning – sophisticated algorithms that enable a machine to be adaptable and trainable at every stage, perceiving and acting through many layers of processing with the efficiency of animals and humans. "Understanding deep learning not only will enable us to build more intelligent machines, but will also help us to better understand human intelligence and the mechanisms of human learning," LeCun says.

Deep learning techniques can be traced back more than 25 years, to around the time LeCun was starting his career. While LeCun was working at Bell Laboratories in the late 1980s, one of several machine-learning methods he developed was a biologically inspired model of image recognition called Convolutional Neural Networks, which has in recent years become widely deployed by Facebook, Google, Microsoft and other high-

Yann LeCun
New York University and Facebook

(Continued on page 3)

IPAM WORKSHOP BLENDS MATH AND POLITICS

Jerry McNerney
U.S. Congressman

Recent political campaigns have demonstrated the power of data analysis and social network analysis. An IPAM workshop in spring 2014 addressed the emerging area of mathematics of politics, with talks by mathematicians, social scientists and politicians. The workshop featured a public lecture by Congressman Jerry McNerney (D-CA 9th District), who holds a PhD in mathematics. He described the organization of campaigns and his experience as a scientist entering politics.

From the other side of the aisle, Richard Yamada, who works for Congressmen Lamar Smith (R-TX) and Larry Bucshon (R-IN) on the House Committee on Science, Space, and Technology, served on a panel discussion on the current role and future of mathematics in politics.

The workshop also included talks by Lynne Vavreck (UCLA, Political Science) on frequent misconceptions about data analytics in campaigns, Don Saari (UC Irvine, Mathematics) on logical inconsistencies in the structure of laws, Roja Bandari (currently at Twitter) on methods for extracting structures and their meanings from social data, and others. ■

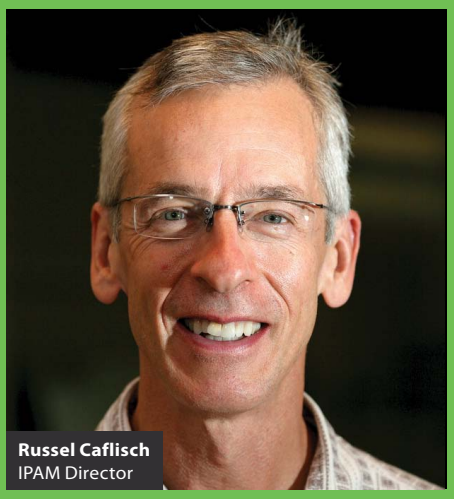
FEATURES

REGULARS

OTHER

NOTE FROM DIRECTOR RUSSEL CAFLISCH

Welcome to IPAM's newsletter for 2014. On the front page you'll see that our newsletter has a new look including our new logo. In addition to the logo's clean modern style, the linkage between the "p" and the "a" symbolizes the close connection between pure and applied math here at IPAM. This logo was designed by Susan Fairbairn, who has contributed to IPAM in many ways!



Russel Caflisch
IPAM Director

When you visit IPAM, you'll also see a new look to the building. The rope sculpture, which is featured in the background of the newsletter header, is still in the lobby, but our seminar room has been completely renovated. Risers in the back provide excellent viewing from every seat, new chairs are much more comfortable, and new lighting has greatly improved the room's appeal. Everyone seems pleased with these changes, and I hope that you will all get a chance to experience it for yourself soon.

The last year has seen ongoing development of some important themes at IPAM. Machine learning continued its prominence in the long program on Materials for Sustainable Energy and the workshop on the Stochastic Gradient Method; we will be offering a workshop on Machine Learning for Many-Particle Systems in 2015. Social science is emerging as a significant topic at IPAM in the workshops on Social Learning and on Mathematics of Politics, and in the upcoming long programs on Traffic Flow Management and on Culture Analytics.

In the coming year, we will have long programs on the very important but challenging topic of Turbulence and on Financial Math, which will address some timely topics such as systemic risk and high frequency trading. In addition to those mentioned above, we will have workshops on Multiple Sequence Alignment, Symmetry and Topology in Quantum Matter, Computational Photography, and Zariski-Dense Subgroups. Two very special programs will be the Blackwell-Tapia Conference and Awards Ceremony and Latinos/as in the Mathematical Sciences Conference.

Most important for IPAM is the renewal process for our main NSF grant, which is currently underway. We received excellent written reviews from our proposal. The next step is a site visit scheduled for late October. I hope to be sharing good news about a successful renewal in the next newsletter. In the meantime, I look forward to seeing you at an IPAM event. ■

MATHEMATICS HELPS CHEMIST UNDERSTAND PROTEIN DYNAMICS

A fortuitous meeting with a mathematician at an IPAM program led to a major breakthrough in Cecilia Clementi's work – with potentially important implications for nanotechnology and biomedical research.

Clementi, a professor of chemistry and of chemical and biomolecular engineering at Rice University, is interested in the dynamics of proteins and other macromolecules – large molecules involved in biological function. Because proteins regulate nearly all biological activity, understanding how they move and interact with neighboring molecules is critical to unraveling some of the most vexing problems in molecular biology, from "protein misfolding" diseases such as Alzheimer's to certain types of cancers. But scientists know relatively little about molecular-level protein dynamics.

"These molecules are extremely large – thousands of atoms," Clementi explains. "The challenge has been that understanding them at the molecular level of detail in order to study the system requires a very complex model spanning the range of relevant time and length scales. You have to take into account the movement and interaction of all of the atoms and water molecules to determine the trajectory of the protein as a function of time, and no standard approach has been able to do that over timescales of biological relevance."

Clementi's group concluded that learning about the molecular mechanisms of such a complex system requires marrying biological and biochemical approaches with a physical and mathematical perspective of the problem. She and her colleagues at Rice have been able to bring

Cecilia Clementi
Rice University

that perspective to their work by teaming with Mauro Maggioni, a mathematician at Duke University, as well as other mathematicians Clementi has met during her nearly decade-long association with IPAM. In the process, they have paved the way toward a novel approach that blends theory, simulation and experimental techniques to characterize protein systems at multiple length and time scales.

Clementi's introduction to IPAM came when she was asked to co-organize and

(*Continued on page 7*)

FROM IPAM TO INDUSTRY: A SCIENTIFIC JOURNEY

Nina Lane graduated from Drexel University in 2013 with a PhD in Materials Engineering

My relationship with IPAM began around 7 ½ years ago when I was hired as a student employee. As an undergraduate in materials engineering at UCLA, I could appreciate the role of math in engineering and the physical sciences, but through IPAM I started to realize that math really encompasses the whole world. I was constantly amazed at the incredible variety of topics that were covered by IPAM programs. Crime hot spots, cryptography, image processing, cognitive science – there were so many problems in the world that involved math! I witnessed the ability of IPAM to recruit participants from around the world with diverse scientific expertise to collaborate on a common problem.

In the fall of 2012, I was fortunate to experience IPAM from the perspective of a program participant. During the last year of my PhD program at Drexel University, I participated in IPAM's long program on Materials Defects. I was writing a thesis on lattice dynamical effects of materials called MAX phases. A large part of my PhD work involved "first-principles" calculations, materials simulations that are based on the fundamental principles of physics. The materials defects program fit in perfectly with my PhD work, and provided a stimulating setting for me to do some thesis writing and collaborate with both young researchers and experts in the field.

The IPAM long program was more fulfilling, well-organized, and useful than I could have imagined. It provided me with opportunities for collaboration, exposure to more diverse modeling techniques, leadership experience (I co-organized the junior seminar series), invaluable relationships with mathematicians, and ultimately, an exciting new job at Intel. During the culminating retreat at Lake Arrowhead, I met Sadasivan Shankar who founded and was leading an effort on Materials Design at Intel and who was attending the reunion conference for IPAM's Chemical Compound Space program. Despite being part of different long programs, we had very similar research interests and my research background fit in remarkably well with his group at Intel, which focuses on materials modeling for process technology development.

Nina Lane
Intel

(*Continued on page 4*)

Machine Learning

(Continued from page 1)

tech companies. "We're seeing a resurgence of interest in deep learning techniques in the last 5-10 years because they are good for handling very large data sets, and can take advantage of the fast computers we now have," LeCun explains. "We can do things with those techniques now that were impossible just a couple of years ago in areas such as computer vision, speech recognition and natural language understanding, and that has sparked a great deal of interest in both academic research and industry."

LeCun's expertise was also of great interest to IPAM, given the applications not only in AI, but also in the sciences and in the statistical analysis of large data sets. "One of the big challenges for mathematics in the coming years will be how to represent natural data," LeCun explains. "We are submerged with it – there is too much for all of the brains on the planet to extract knowledge out of it, so computers will have to do that for us, and we will have to come up with those methods. IPAM understands this and is instrumental in these efforts, and that's why they brought me on."

As a member of IPAM's Science Advisory Board, LeCun helps to evaluate proposals for IPAM's programs and workshops. He has also been influential as an IPAM organizer and speaker. Most notably, LeCun was the main organizer of the 2012 summer school program Deep Learning, Feature Learning (cosponsored by the Canadian Institute for Advanced Research). "It was clear that deep learning was taking off and that although there was a lot of mathematics needed around this, most of the research had been done by computer scientists and theoretical neuroscientists," LeCun says. "Our goal was to get young mathematicians who were interested in these questions to learn the existing techniques and begin to help tackle the questions surrounding deep learning. The program was an incredible success – people from the math community came from all over the world and became interested in these questions."

LeCun continues: "There is now a sense that in the future, many essential aspects of human communication and access to information will rely on AI. IPAM is very effective at bringing together practitioners and mathematicians so that the practitioners explain the problems they are encountering, and the mathematicians can bring in techniques that might be relevant. And when that happens, interesting things can be born."

Ultimately, LeCun is interested in understanding intelligence in general – artificial or natural. "This is one of the major scientific questions of our time – how does the brain work," he says. "We can't answer that solely by analyzing the molecular processes. That would be like explaining flight by studying the details of feathers of birds – they are important, but what's more important are the principles of aerodynamics. By understanding the principles of intelligence, whether it is natural or artificial, we can better understand how the brain works, and in the process we can benefit from the many practical applications of artificial intelligence." ■

NEWS AND NOTES

NEWLY RENOVATED IPAM LECTURE HALL UNVEILED

Dean of Physical Sciences Joseph Rudnick and IPAM Director Russel Caflisch officially unveiled our newly renovated lecture hall in a ribbon cutting ceremony held on April 25, 2014. The renovations include raised platforms for better sight lines, new seats, and state-of-the-art projection, sound, and lighting equipment. IPAM gratefully thanks its Frontiers Society members and donors for their generous support, which made the needed improvements possible.

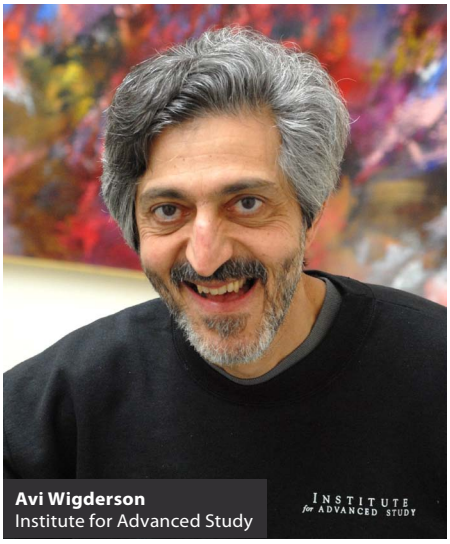
Russel Caflisch and Joseph Rudnick
UCLA

IPAM RELEASES NEW WEBSITE

IPAM will soon release its new and improved website with a new design that incorporates our new logo and slogan. Users will find that it is easier to locate current and upcoming programs, as well as videos of past programs.

2014 GREEN FAMILY LECTURES FEATURED AVI WIGDERSON

Avi Wigderson, Professor of Mathematics at the Institute for Advanced Study, gave IPAM's Green Family Lectures on May 19 and 20, 2014. His first talk presented the computational theory of randomness to a general audience. His second talk discussed the role of the determinant and the permanent in enumerative combinatorics, statistical and quantum physics, and the theory of computation. Wigderson leads IAS's Computer Science and Discrete Math Program. He was an invited speaker at the International Congress of Mathematicians (ICM) on two occasions, and was awarded the Nevanlinna Prize in 1994. He gave the AMS Gibbs Lectures in 2008, and was elected to the National Academy of Sciences in 2013.



Avi Wigderson
Institute for Advanced Study

HUGHES-OLIVER TO RECEIVE 2014 BLACKWELL-TAPIA PRIZE

On November 15, Jacqueline Hughes-Oliver, Professor of Statistics, North Carolina State University will be presented with the 2014 Blackwell-Tapia Prize. The prize is awarded every other year in honor of the legacy of David H. Blackwell and Richard A. Tapia, two distinguished mathematical scientists who have been inspirations to more than a generation of African American, Latino/Latina, and Native American students and professionals in the mathematical sciences. Hughes-

Jacqueline Hughes-Oliver
North Carolina State University

Oliver has made important contributions in a number of statistical research areas including methodological research on prediction and classification, variable and model selection with dimension reduction, design of experiments, and spatial modeling. She has worked passionately on the cause of increasing diversity of individuals working in the statistical and mathematical sciences. The awards ceremony is part of the Eighth Blackwell-Tapia Conference, to be held at IPAM on Nov. 14-15, 2014.

A Scientific Journey

(*Continued from page 3*)

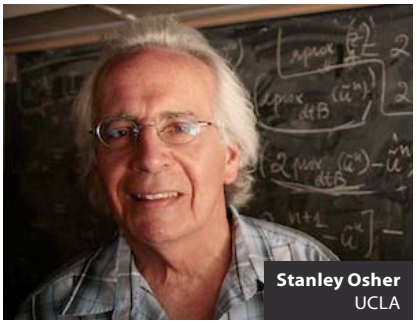
With the support of Dr. Shankar, I was hired by Intel and joined Intel's Rotation Engineer Program. Recent graduates develop leadership skills while working on challenging technical problems and get exposed to a large part of the company in 18 months. It has been the perfect program for me, since I enjoy learning about new things and picking up new skills. My technical background is well-aligned with my first rotation in Intel's materials modeling group, which sponsored an undergraduate research project in IPAM's RIPS program. As a member of the group, I was able to sit in on a few of the team meetings. This time, I got to witness – from Intel's end – how IPAM researchers helped advance the work we do in industry.

As my relationship with IPAM has evolved over the years, it has remained clear to me how important it is for scientists, mathematicians, and engineers to branch out and extend our network to people outside of our immediate research circle – whether that means talking to new people, expanding research skills, attending talks on new topics, or chatting with a participant from another program. I am looking forward to maintaining my connection with IPAM throughout my career. ■

RECOGNITION

OSHER RECEIVES CARL FRIEDRICH GAUSS PRIZE

At the 2014 International Congress of Mathematicians in Seoul, Korea, Stanley Osher received the Carl Friedrich Gauss Prize for Applications of Mathematics, which is granted jointly by the International Mathematical Union (IMU) and the German Mathematical Society. The prize citation states that Osher received the prize "for his influential contributions to several fields in applied mathematics, and for his far-ranging inventions that have changed our conception of physical, perceptual, and mathematical concepts, giving us new tools to apprehend the world." Along with the Fields Medal, the Gauss Prize is one of only four prizes awarded by the IMU, and it is one of the highest honors that a mathematician can receive. Osher is IPAM's Director for Special Projects and has been closely involved with IPAM since its inception in 2000.



Stanley Osher
UCLA

OTHER IPAM "ALUMNI" HONORED AT THE ICM

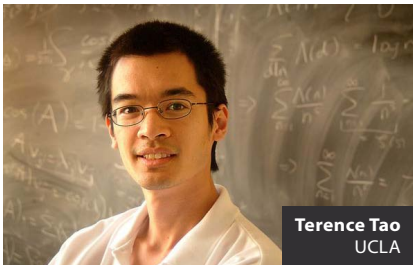
Several IPAM board members and "alumni" gave plenary lectures and received awards at the 2014 International Congress of Mathematicians. Workshop organizers Subhash Khot and Martin Hairer won the Nevanlinna Prize and the Fields Medal, respectively. Science Advisory Board members Emmanuel Candes and Alexei Borodin, workshop organizers Mikhail Lyubich, Ben Green, and Alan Frieze, and workshop speakers Frank Merle and Benoit Perthame gave plenary lectures.

SIAM RECOGNIZES IPAM PARTICIPANTS

A number of IPAM participants, speakers, organizers and board members were honored at the 2014 SIAM meeting. Weinan E received the Theodore von Kármán Prize. John Lowengrub was awarded the Julian Cole Lectureship. Irene Gamba gave the AWM-SIAM Sonia Kovalevsky Lecture. The author of one of the Student Paper Prizes, Carlos Fernandez-Granda, will be a speaker for IPAM's Computational Photography workshop in 2015. All four authors of the three Outstanding Paper Prizes are frequent visitors to IPAM as well.

TAO RECOGNIZED FOR HIS MANY CONTRIBUTIONS TO MATHEMATICS

Congratulations to Terence Tao for several honors he received this year. In June, he was one of five winners of the inaugural Breakthrough Prize in Mathematics funded by Mark Zuckerberg and Yuri Milner. Tao was selected for his numerous innovative contributions to harmonic analysis, combinatorics, partial differential equations and analytic number theory. Additionally, he was selected by the Royal Society in August to receive the 2014 Royal Medal for physical sciences for his "many deep and varied contributions to mathematics." Finally, Tao was named a Highly Cited Researcher in a list generated by Thomson Reuters in June 2014. Tao is a member of IPAM's Science Advisory Board and has been a speaker, organizer, and participant of many IPAM programs.



Terence Tao
UCLA

IPAM BOARD MEMBERS ELECTED TO THE AMERICAN ACADEMY AND NATIONAL ACADEMIES

Recent academy elections recognized a number of individuals from IPAM's Science Advisory Board (SAB) and Board of Trustees (BT). New members of the National Academy of Science include Emmanuel Candès, Cynthia Dwork, and Bin Yu from the SAB. Candès was also selected for the American Academy of Arts and Sciences. Tony Chan, who was elected to the National Academy of Engineering, was co-founder of IPAM and is now a member of the BT.

FRONTIERS SOCIETY

Join Today!

Join or renew your membership in IPAM's Frontiers Society at the **Champion ($1000), Visionary ($500),** or **Innovator ($100)** levels to support IPAM's innovative programs that apply mathematics to real-world problems. Support from the Frontiers Society allowed IPAM to renovate its lecture hall earlier this year, which has improved the experience of our workshop participants. We make several child care grants each year to program participants with young children, which allows them to participate fully in the IPAM program. Support from individuals like you also enabled us to redesign our website.

Your gift will go towards activities and endeavors that we cannot support with federal money. To read more about the Frontiers Society including benefits and fundraising priorities, and to make a contribution to IPAM at any level, go to **ipam.ucla.edu/donate**.

2013-14 MEMBERS

IPAM wishes to thank the following individuals who joined or renewed their memembership in the past year, and all others who donated.

CHAMPIONS ($1000)

Ms. Tanya Beder and Mr. Joseph H. Bretton
Dr. Tony F. and Mrs. Monica K. Chan
Mr. Aluizio M. Cruz and Ms. Quelita Moreno
Mr. James E. Gidney, Jr.
Dr. Mark L. Green and Mrs. Kathryn Kert Green
Dr. Alfred W. and Mrs. Virginia D. Hales
Mr. John W. and Mrs. Jody A. Jacobs
Dr. Sallie Keller and Mr. William Safron
Mr. Mark A. and Mrs. Carroll C. Maltzman
Dr. Maria P. McGee
Ms. Holly Goldberg Sloan and Mr. Gary Rosen
Drs. Ronald J. and Sharon S. Stern

VISIONARIES ($500)

Dr. Russel E. Caflisch
Mr. Nicholas and Ms. Nancy Fortis
Dr. James C. and Mrs. Diana K. Fraser
Dr. Stanley J. Osher
Dr. Jeffrey Saltzman and Ms. Laurel Rogers

INNOVATORS ($100)

Anonymous
Mr. Robert Baker
Mr. John M. and Mrs. Meg W. Bossert
Dr. John B. and Mrs. Dolores Garnett
Dr. Frank and Mrs. Carla Graziani
Dr. Bryna Kra
Dr. Lothrop and Mrs. Ingeborg E. Mittenthal
Mr. Vijay Pedapudi
Dr. Stan Schein and Ms. Mae Greenwald
Mr. James W. Stevenson
Dr. Tatiana Toro and Mr. Daniel Pollack

UPCOMING PROGRAMS

2014-2015 LONG PROGRAMS

Mathematics of Turbulence
September 8- December 12, 2014

Broad Perspectives and New Directions in Financial Mathematics
March 9 - June 12, 2015

2015 WORKSHOPS

Multiple Sequence Alignment
January 12 - 16, 2015

Symmetry and Topology in Quantum Matter
January 26 - 30, 2015

Computational Photography and Intelligent Cameras
February 4 - 6, 2015

Zariski-dense Subgroups
February 9 - 13, 2015

Machine Learning for Many-Particle Systems
February 23 - 27, 2015

2014-2015 OTHER PROGRAMS

Blackwell-Tapia Conference and Awards Ceremony
November 14 - 15, 2014

Latinos/as in the Mathematical Sciences Conference
April 9 - 11, 2015

Research in Industrial Projects for Students
Hong Kong, June 8 - August 7, 2015
Los Angeles, June 22 - August 21, 2015
Berlin, June 29 - August 21, 2015

Graduate Summer School: Games & Contracts for Cyber-Physical Security
July 7 - 23, 2015

2015-2016 LONG PROGRAMS

Mathematical Approaches for Traffic Flow Management
September 8 - December 11, 2015

Culture Analytics
March 7 - June 10, 2016

CALL FOR PROPOSALS

IPAM seeks proposals from the mathematical, statistical, and scientific communities for long programs, winter workshops, summer programs, and exploratory workshops. Proposals are reviewed by IPAM's Science Advisory Board (SAB) at its annual meeting in November. To receive full consideration, please send your program idea to the IPAM Director at director@ipam.ucla.edu by **October 1**.

WINTER WORKSHOPS

Winter workshops are typically five days in length, with 20-25 presentations. The proposal should include a short description of the mathematical and scientific content, names of individuals to serve on the organizing committee, and names of individuals that you would like to invite as speakers or participants. The SAB will consider proposals for winter 2016 at the upcoming meeting.

SUMMER SCHOOLS

Summer schools are generally two or three weeks in length and incorporate both tutorials and research talks illustrating applications. They are directed toward graduate students and postdocs. The requirements for summer school proposals are comparable to those for winter workshops. The SAB will consider proposals for summer 2016 in November.

LONG PROGRAMS

Long programs generally have two complementary streams: one mathematical and one (or more) from other related scientific disciplines where there is the potential for a fruitful and exciting interaction. Alternatively, this might be an interaction between two disparate branches of mathematics. A long program opens with tutorials, followed by four one-week workshops and a culminating workshop.

The proposal should include a brief description of the topic, names of individuals to serve on the organizing committee, and a preliminary list of faculty, postdocs, graduate students, and representatives of industry and government you would like to invite. A Long Program Proposal Template is available online. Proposals for academic year 2016-2017 will be reviewed at the next SAB meeting.

EXPLORATORY WORKSHOPS

Exploratory workshops address urgent problems that mathematics may help solve. They are two or three days long, and can be organized in less than a year. The proposal should follow the guidelines for Winter Workshops, above, and will be considered at any time.

Mark Your Calendars

February 9, 2015. Application deadline for Latinos/as in the Mathematical Sciences Conference, to be held at IPAM on April 9-11, 2015.

February 12, 2015. Application deadline for IPAM's Research in Industrial Projects for Students (RIPS) Program in Los Angeles, Hong Kong, and Berlin.

March 31, 2015. Application deadline for IPAM's 2015 summer school entitled Games and Contracts for Cyber-Physical Security, to be held in July.

May 18-19, 2015. The 2015 Green Family Lecture Series will feature Andrew Lo, Professor at the MIT Sloan School of Management and Director of the MIT Laboratory for Financial Engineering.

Stay connected with IPAM with regular news posts, event notifications and photos.

Subscribe to the IPAM YouTube Channel and view our public lecture videos.

Protein Dynamics

(*Continued from page 2*)

participate in a three-month program, Bridging Time and Length Scales in Materials Science and Bio-Physics, which was held in late 2005. The program brought together scientists and mathematicians with expertise in modeling, analysis and computation on multiple time and length scales, from the atomistic to the continuum, in an effort to facilitate modeling that would combine these different techniques. "It was a big success," Clementi recalls. "We connected experts from different communities and everyone learned a great deal from each other." From a personal standpoint, Clementi says, she learned about mathematical approaches and ended up forging collaborations with two other participants, Yannis Kevrekidis and Kurt Kremer, which continued well beyond the program.

The program spawned two reunion conferences, one in 2006 and one in 2007. At the latter meeting Clementi met Maggioni, who was there to participate in an ongoing program on geometry. "I was working on methods to reduce the dimensionality of our system so that it could be studied, and there was a lot of interest in that topic among the participants," Clementi explains. "So they asked me to give a talk for their program." Maggioni, in particular, had developed a geometric approach for reducing variables of complex systems from thousands to a few so that they could be described in simple ways, and was looking to apply his methods to biology. Clementi had that expertise, and the need for exactly what Maggioni was offering. They have been collaborating ever since – their pairing leading to two major published papers and ambitious plans for the future, including development of a computer software package for studying proteins.

The implications of their work are wide-ranging. At a practical level, the ability to model the dynamics of specific biological systems could lead to important breakthroughs in the understanding of what goes wrong in diseases involving particular proteins. Clementi's group is currently studying two such protein-related disorders. The figure below from their work shows that significant understanding can come from just two well-chosen diffusion coefficients (DC). More broadly, the ability to take complex multidimensional systems and reduce them to a few variables so that they can be studied is of considerable interest in other fields, including nanoscience.

Clementi has also continued her involvement with IPAM. She was a participant in the long program Navigating Chemical Compound Space in 2011 and will be a speaker in a workshop on machine learning in 2015. "What I like about IPAM is that it's a mathematical institute that promotes discussions across fields," she says. "Many people in other disciplines have already dealt with the problems that we are facing, and have methods that we can learn from. And on the other hand, some of our problems present the types of new challenges that mathematicians are looking for. IPAM isn't just mathematicians talking among each other. It links with other disciplines in a way that is approachable, so that we can understand and use the math. Everyone at the meetings wants to collaborate across traditional disciplinary boundaries. IPAM is really unique in that respect." ■

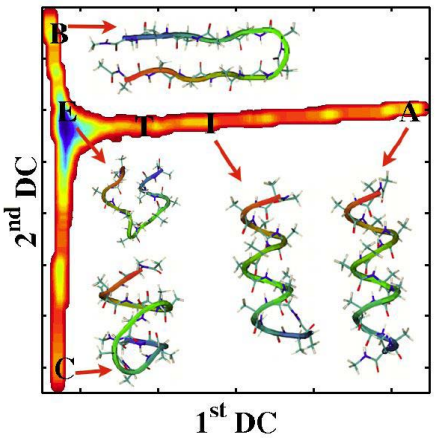


Figure from "Rapid Exploration of Configuration Space with Diffusion-Map-Directed Molecular Dynamics", Wenwei Zheng, Mary A. Rohrdanz, and Cecilia Clementi, J. Phys. Chem. B 2013, 117, 12769-12776.

Institute for Pure and Applied Mathematics

a National Science Foundation Math Institute
at the University of California, Los Angeles

405 Hilgard Avenue
Box 957121, 460 Portola Plaza
Los Angeles, CA 90095
p: 310-825-4755
f: 310-825-4756
www.ipam.ucla.edu

math changes everything.

IPAM LONG PROGRAM: BROAD PERSPECTIVES AND NEW DIRECTIONS IN FINANCIAL MATHEMATICS

Quantitative finance has largely been based on perfect replication, which is essential in the Black and Scholes model for pricing and hedging. But perfect replication became unsound during the financial crisis of 2007-2008 due to dire illiquidity problems that caused the collapse of several major firms. Broad perspectives and new directions in financial mathematics are imperative for responding to this failure of perfect replication.

In spring 2015, IPAM will host a 14-week program that will address these issues, highlighted by four workshops. The first of these will focus on systemic risk in financial networks, including capital requirements, central clearing, default contagion through insolvency and illiquidity, and nonlinear feedback effects. The second will focus on high frequency and algorithmic trading and especially their impact on the stability and integrity of the financial system. Financialization of commodity markets and how they have changed following their connection with equity markets will be the topic of the third workshop. The final workshop will discuss new insights into forensic analysis of financial data. During the last workshop Andrew Lo (MIT Sloan School of Management) will present the Green Family Lectures on May 18-19.

IPAM seeks mathematicians, economists, regulators, and experts from the finance industry to participate and contribute to this new body of research. Financial support is available for junior participants. ■