Institute for Pure and Applied Mathematics, UCLA
Annual Progress Report for 2011-2012
Award #0931852
June 3, 2013

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EXECUTIVE SUMMARY

IPAM held two long programs in 2011-2012

- High Throughput Genomics (fall 2011)
- Computational Methods in High Energy Density Plasmas (spring 2012)

2012 summer programs included:

- RIPS-LA (36 students, nine sponsors)
- RIPS-Hong Kong (8 U.S. students) in partnership with Hong Kong University of Science and Technology
- Deep Learning, Feature Learning summer school

Workshops during 2011-2012 included:

- Large Scale Multimedia Search
- Mathematical Challenges in Graphical Models and Message-Passing Algorithms
- Challenges in Synthetic Aperture Radar
- Nonlocal PDEs, Variational Problems and their Applications
- Traffic Flow Modeling (exploratory workshop)
- Modern Math Workshop and reception at SACNAS (with other math institutes)
- Future Directions in Mathematics Workshop with DOD
- Reunion conferences for long programs Combinatorics, Optimization, Climate Modeling, and Kinetic Transport

IPAM continues to raise private funds through its membership society. IPAM also held its first "donor salon" in September, featuring a talk on cybersecurity by Rafail Ostrovsky.

IPAM published its third annual newsletter on September 1, 2011.

IPAM worked with a consultant to improve our program evaluation methods.

Jinqiao Duan was hired as IPAM's Associate Director on September 1. Henry Cohn, Bin Yu, and Amie Wilkinson joined the Science Advisory Board. Bryna Kra joined the Board of Trustees.

The inaugural Green Family Lecture Series featured Nobel Laureate Walter Kohn, who gave three lectures on alternative energy, Density Functional Theory, and macular degeneration.

IPAM sponsored two other public lectures during the year, one by Carlos Bustamante on genomics, and the other by Ed Moses on the national ignition facility.

IPAM made some additional improvements to the kitchen, which is used by our visitors, earlier this year. We also purchased and installed video equipment in the lecture hall and hired a videographer. We now record most of our lectures.

A. PARTICIPANT LIST

A list of all participants in IPAM programs will be provided in electronic form (Excel). The list includes participant lists for programs whose start dates fall between September 1, 2011 and August 31, 2012. This list includes our summer 2012 programs. It includes programs that were supported by other sources.

B. FINANCIAL SUPPORT LIST

A list of participants that received support from IPAM is provided in electronic form (Excel). The list includes all funded participants of programs that occurred between August 1, 2011 and August 31, 2012. It includes participants of our 2011 summer school, because this program was accidentally excluded from the finance support list for 2010-2011. It also includes our summer 2012 programs. It does not include programs that were entirely supported by other sources.

C. INCOME AND EXPENDITURE REPORT

This table covers years 1 and 2 of grant #0931852.

	A	B	C	D	E	F
			A-B=C		B+D=E	A-E=F
Budget Category	**Appropriation Year 1 and 2**	**Actual Expenses through August 2012**	**Current Balance as of August 2012**	**Encumbered Expenses as of August 2012**	**Total Expenses as of August 2012**	**Projected Balance as of August 2012**
A. Operations Fund	**$4,540,000**	**$3,923,973**	**$616,027**	**$267,640**	**$4,191,613**	**$348,387**
B. Participant Costs	**$4,460,000**	**$3,050,929**	**$1,409,071**	**$20,660**	**$3,071,589**	**$1,388,411**
5-Year Total Budget	**$9,000,000**	**$6,974,902**	**$2,025,098**	**$288,300**	**$7,263,202**	**$1,736,798**

IPAM received funding of $9,000,000 for the first two years of this grant. Expenditures in years 1 and 2 totaled $6,974,902 and $288,300 is encumbered for a total of $7,263,202 in expenses. The Grant balance is $1,736,798 at the end of year 2.

Expenditures for the two years ended August 31, 2012:

A. The Operational Fund (salaries, benefits, equipment, supplies, and travel including overhead) for first two years budget has an appropriation of $4,540,000 with total expenditures of $4,191,613.

B. Participant Support Costs for the first two years budget has an appropriation of $4,460,000 with total expenditures of $3,071,589.

The balance of $1,736,798 as of August 31, 2012 is due to the nature of the budget. The budget is funded at constant annual increment of $4,500,000 per year for five years. During the first year IPAM was spending down the carry-forward from Grant #0439872-01315100. IPAM manages its constant annual increments of $4,500,000 in a non-constant manner over the life of the grant. We expect our participant and operational expenses to increase over the remaining three years of the grant.

D.POSTDOCTORAL PLACEMENT LIST

In 2009, IPAM appointed 8 postdoctoral scholars through the NSF Mathematical Sciences Institutes Postdoctoral Scholars program. IPAM placed the postdoctoral researchers in a research group at a university; one postdoc was assigned to a private, for-profit research group (Placental Analytics) with a UCLA affiliation. All placements were in the U.S. Two of the original eight postdocs were women, and two were Hispanic. All completed their PhDs at a U.S. institution; half of them were U.S. citizens.

Five of them (see table below) continued the position for a second year (2010-2011). One of them, Ricardo Alonso, continued the position for a third year, through July 31, 2012.

IPAM's NSF Mathematical Sciences Institutes Postdoctoral Scholars (Starting Sept. 2009)					
Last Name	**First Name**	**End Date**	**Institution**	**Department**	**Research Topic**
Alonso	*Ricardo*	*7/31/2012*	*Rice*	*Comp Appl Math*	*inverse problems*
Athavale	Prashant	6/30/2011	Placental Analytics/UCLA	Math	placenta imaging
Baskaran	Arvind	8/31/2010	UC Irvine	Math	materials science
Duarte	Marco	8/31/2010	Princeton	Math and EE	compressed sensing
Leicht	Elizabeth	6/30/2010	UC Davis	Mechanical Eng.	network analysis
Szlam	Arthur	6/30/2011	NYU	Computer Science	machine learning
Vermesi	Brigitta	7/31/2011	University of Washington	Math and MS	probability, math phys
Wen	Zaiwen	2/28/2011	Rice	Comp Appl Math	optimization

E. MATH INSTITUTE DIRECTORS' MEETING REPORT

Mathematical Institutes Directors meeting
May 11-12, 2012
Minutes and Report

You will find the minutes from this meeting in the appendix (Appendix 1).

F. PARTICIPANT SUMMARY

In fiscal year 2011-2012, 2,355 participants enrolled in two long programs, 23 workshops, four reunion conferences, and four summer programs. IPAM actively seeks women and members of underrepresented ethnic groups to participate in its programs as organizers, speakers and participants. While most participants report their gender and ethnicity, some choose not to do so, and some did not respond to our request for the data. In this year, 12.5% of IPAM participants were members of an underrepresented minority group (combined), and almost 25% were women. See table F-1, below.

Table F-1: All Participants' Gender and Ethnicity by Program Type (2011-2012)

Program Type	Total Participants	Female*	No. Reporting Gender	Underrepresented Ethnic Groups*			No. Reporting Ethnicity
				American Indian	Black	Hispanic	
Long Programs	144	34	142	0	3	5	131
Workshops	1828	454	1797	4	49	166	1612
Summer Programs	299	65	295	0	8	20	256
Reunion Conferences	84	21	82	0	0	5	77
Total	2355	574	2316	4	60	196	2076
Percent of No. Reporting		24.8%		0.2%	2.9%	9.4%	

IPAM also looked at unique participants for 2011-2012. There were 1439 unique participants. Out of 1412 participants reporting gender, 357 of them (25.3%) were women. Out of 1223 reporting ethnicity, 189 of them (15.5%) reported that they are a member of one or more underrepresented ethnic groups.

IPAM tries to balance the expectation that we primarily serve the U.S. community (citizens and permanent residents) with the goal of attracting the best organizers, speakers and participants in the relevant fields. See Table F-2.

Table F-2: All Participants' Citizenship by Program Type (2011-12)

Program Type	U.S. Citizens & Permanent Residents	No. Reporting Citizenship & Residency	percent
Long Programs	79	144	55%
Workshops	1075	1767	61%
Summer Programs	150	279	54%
Reunion Conferences	45	83	54%
Total	1349	2273	59.35%

Among IPAM's unique participants for the year, 60.2% were citizens or permanent residents.

The majority (90%) of the year's participants of IPAM programs hold academic positions (faculty, postdoc, graduate student, or undergraduate student). Out of the remaining 10% of participants, 136 held positions in government or military, and 106 worked in industry. The following sections provide summary data for the requested sub-groups: postdocs, graduate students, and undergraduate students.

G. POSTDOCTORAL PROGRAM SUMMARY

Postdocs attend IPAM's workshops, long programs, reunion conferences, and summer school, and a few serve as academic mentors in RIPS. IPAM also had one postdoc in 2011-2012 who was finishing his last year of the "NSF Mathematical Sciences Institutes Postdoctoral Scholars program" (see section D) but he is not included in this summary unless he also attended an IPAM long program, workshop, summer program or reunion conference.

Table G-1: Postdocs' Gender and Ethnicity by Program Type (2011-2012)

Program Type	Total Participants	Female*	No. Reporting Gender	Underrepresented Ethnic Groups*			No. Reporting Ethnicity
				American Indian	Black	Hispanic	
Long Programs	24	5	23	0	1	1	20
Workshops	276	62	267	0	9	22	245
Summer Programs	20	3	19	0	0	2	15
Reunion Conferences	16	7	16	0	0	0	16
Total	336	77	325	0	10	25	296
Percent of No. Reporting		23.7%		0.0%	3.4%	8.4%	

all members of underrepresented groups 35 11.82%

*gender and ethnicity is self-reported

Table G-2: Postdocs' Citizenship by Program Type (2011-2012)

Program Type	U.S. Citizens & Permanent Residents	No. Reporting Citizenship & Residency	percent
Long Programs	11	24	46%
Workshops	131	275	48%
Summer Programs	11	19	58%
Reunion Conferences	4	16	25%
Total	157	334	47.01%

H. GRADUATE STUDENT PROGRAM SUMMARY

Graduate Students participate in IPAM's workshops, long programs, reunion conferences, and summer school, and a few serve as academic mentors in our undergraduate summer programs. Graduate students often find a compelling thesis topic at an IPAM program, and also frequently make contacts that lead to their first job. See tables H-1 and H-2.

Table H-1: Graduate Students's Gender and Ethnicity by Program Type (2011-2012)

Program Type	Total Participants	Female*	No. Reporting Gender	Underrepresented Ethnic Groups*			No. Reporting Ethnicity
				American Indian	Black	Hispanic	
Long Programs	51	12	50	0	1	3	51
Workshops	541	150	536	0	16	57	506
Summer Programs	113	15	111	0	1	4	103
Reunion Conferences	19	8	19	0	0	1	18
Total	724	185	716	0	18	65	678
Percent of No. Reporting		25.8%		0.0%	2.7%	9.6%	

all members of underrepresented groups 83 12.24%

*gender and ethnicity is self-reported

Table H-2: U.S. Graduate Students' Citizenship by Program Type (2011-12)

Program Type	U.S. Citizens & Permanent Residents	No. Reporting Citizenship & Residency	percent
Long Programs	18	51	35%
Workshops	230	537	43%
Summer Programs	32	112	29%
Reunion Conferences	11	19	58%
Total	291	719	40.47%

I. UNDERGRADUATE STUDENT PROGRAM SUMMARY

Undergraduate students participate in our summer programs, Research in Industrial Projects for Students (RIPS) in Los Angeles and Hong Kong. RIPS Projects Day is listed as a separate workshop, as we invited undergraduate students and other guests interested industrial applications of math. A detailed description of RIPS-LA and Hong Kong as well as comments from participants is available in section J of this report.

In addition, IPAM was the lead organizer of the Modern Math Workshop, held the day before the National Meeting of SACNAS. The participants included undergraduate students.

Undergraduate students do not participate in any IPAM long programs or reunion conferences.

Table F-1: Undergraduates' Gender and Ethnicity by Program Type (2011-2012)

Program Type	Total Participants	Female*	No. Reporting Gender	Underrepresented Ethnic Groups*			No. Reporting Ethnicity
				American Indian	Black	Hispanic	
Workshops	110	62	110	0	14	64	102
Summer Programs	81	35	81	0	5	12	110
Total	81	35	81	0	5	12	110
Percent of No. Reporting		43.2%		0.0%	4.5%	10.9%	

all members of underrepresented groups 17 15.45%

*gender and ethnicity is self-reported

Table F-2: Undergraduates' Citizenship by Program Type (2011-2012)

Program Type	U.S. Citizens & Permanent Residents	No. Reporting Citizenship & Residency	percent
Workshops	92	103	89%
Summer Programs	56	81	69%
Total	148	184	80.43%

J. PROGRAM DESCRIPTION

The programs are listed in chronological order by start date. The list includes all IPAM programs from September 1, 2011 through August 31, 2012:

- Two long programs, and the workshops associated with each of them
- Five IPAM independent workshops, most of which are five days in length
- Three summer programs
- Four reunion conferences of long programs held at IPAM in previous years
- Three public lectures plus the Green Family Lecture Series
- A few miscellaneous programs sponsored or cosponsored by IPAM (some of which were supported by other sources, including other federal agencies)

Public lectures feature a speaker with a national reputation who speaks on a topic of broad interest to an audience that includes non-scientists. IPAM's first public lecture of 2011-2012 featured Michael Brenner and was co-sponsored with the math department; IPAM had a supporting role. Two additional public lectures, given by Carlos Bustamante (Stanford) and Ed Moses (NIF), were held during workshops (they also gave research talks during the workshop) and are described below. Additionally, IPAM offered three talks featuring physicist Walter Kohn as part of the inaugural **Green Family Lecture Series.**

Most IPAM workshops include **poster sessions**; all participants are invited to present a poster, but graduate students are especially encouraged to participate.

LONG PROGRAM: Mathematical and Computational Approaches in High-Throughput Genomics. September 12 - December 16, 2011

Organizing Committee:

Eleazar Eskin (UCLA, Computer Science)
Phil Green (University of Washington)
Stanley Nelson (UCLA)
Lior Pachter (UC Berkeley)
Matteo Pellegrini (UCLA, Molecular, Cell, and Developmental Biology)
Sebastien Roch (UCLA, Mathematics)
Eric Schadt (Pacific Biosciences)
Elizabeth Thompson (University of Washington)
Wing Wong (Stanford University)

The program involved a community of senior and junior researchers. Most participants were in residence at IPAM continuously for the fourteen weeks. The program opened with tutorials, followed by four major workshops, one "mini-workshop," and a culminating workshop at UCLA's Lake Arrowhead Conference Center. Between the workshops there was series of seminars and collaborative activities involving the long-term and short-term participants, as well as visitors.

Full and partial support for participation was awarded. Support for individual workshops was also available. Recent PhD's, graduate students, and researchers in the early stages of their career were especially encouraged to apply.

Scientific Overview:

Biological sciences have been transformed over the past two decades by the development of technologies capable of performing large-scale measurements of cellular states. In particular, DNA sequencing instruments have undergone an extraordinary increase in efficiency during the past few years that has reduced the time and cost required to sequence billions of bases by several orders of magnitude. This is revolutionizing the scale and potential applications of genomic studies, and creating an enormous need to develop mathematical and computational infrastructures to meet emerging data analysis challenges. To name just a few examples, applications requiring the development of novel mathematical and statistical frameworks include the reconstruction of RNA transcript populations, identifying sequence variations (both single-nucleotide and segmental) and exploring their disease associations, locating the sites of protein-DNA interactions, elucidating population histories, and reconstructing microbial communities that colonize particular hosts or environmental niches. This long program brought together mathematical and computational scientists, sequencing technology developers in both industry and academia, and the biologists who use the instruments for particular research applications. It offered a unique opportunity to foster interactions between these three communities over an extended period of time and advance the mathematical foundations of the field.

We conducted anonymous pre- and post-surveys of Genomics participants. The results of the surveys help us measure the success of the program as well as help us address weaknesses. Here are some comments from the surveys:

- It was an incredible opportunity to meet leading researchers, establish collaborations, get updated with new trends and technologies.
- Being one of the more junior participants, I feel I got a very good perspective now of the field, its challenges and also the work being done in other groups, which I lacked before.
- I work at a small college w/o colleagues working in my area. It has been extremely useful to me to be around others working on similar projects (both within my field & outside it). I suspect I will continue collaborations and communications with people I have met here at IPAM.
- It's not impossible to collaborate with mathematicians; however, if they are not in the same building or even at a different university, it's hardly done. It was really good to have everybody in the same building.
- The seminars and workshops were very diverse, touched many subjects in cutting edge research fields. The program unified many researchers and gave opportunities for collaboration.
- I was able to establish two very productive collaborations with graduate students in the program, and I think these will lead to several papers.
- I feel that there is potential for manycollaborations as a result of this workshop, mostly between junior and senior researchers.
- I thought IPAM did a very good job providing just the right amount of structured and unstructured interaction.

In addition, we conducted a survey of participants in April 2013. Here are selected responses to the following two questions:

Please briefly describe any collaborations which grew out of your stay at IPAM:

A collaboration with Bogdan Pasaniuc (now at UCLA) - resulted in one paper and another currently in press. We focus on methods for ancestry inference and geographic localization. In addition, I am in touch with the Eskin group (we worked on a methods project before and plan to collaborate again in the near future), and with Susana Eyheramendy (participating in a data analysis carried out in her group). - Yael Baran, Computer Science, Tel Aviv University

During my stay at IPAM, I met a graduate student (David Koslicki) who became my postdoc for 6 months and with whom I am likely to keep collaborating on problems at the interface of mathematics and genomics. – Simon Foucart, Mathematics, Drexel University

Vladimir Minin has been advising me and is on my dissertation committee--he is at my institution, but IPAM cemented our collaborative relationship. - Christopher Glazner, Statistics, University of Washington

I have a fruitful ongoing collaboration with Prof. Paul Medvedev whom I met during my stay at IPAM. I also collaborated with Prof. Jo Hardin whom I met at IPAM on a paper. - David Golan, Statistics, Tel Aviv University

The above manuscript is part of a collaboration with David Golan that was initiated at IPAM. - Jo Hardin, Mathematics, Pomona College

Darren Kessner and John Novembre (both UCLA) are working on pooled sequencing data as well and they have developped a programme HARP to infer haplotypes of pooled sequence data. My student Agnes Jonas and I are currrently testing this programme on a data set of experimental evolution of Drosophila species. - Carolin Kosiol, Institute of Population Genetics, University of Veterinary Medicine

I met Simon Foucart (assistant professor, mathematics, Drexel University) during my stay at IPAM. He took me on as a postdoc for 9 months, and we have continued collaborating since then. - David Koslicki, Mathematics, Oregon State University

I started a collaboration with Dr. Shihua Zhang from the Chinese Academy of Sciences during my stay at IPAM. We talked about a paper I recently published, "Li, J.J., Jiang, C., Brown, J., Huang, H., and Bickel, P., “Sparse linear modeling of next-generation mRNA sequencing (RNA-Seq) data for isoform discovery and abundance estimation,” Proceedings of the National Academy of Sciences, Vol. 108, No. 50, 2011, pp. 19867–19872" and came up with a new idea of extending the method to replicate data. We continued our collaboration after the IPAM program, and we both look forward to more collaborative opportunities in the future. - Jingyi Li, Biostatistics, University of California Berkeley

During my participation in GEN2011, I started a collaboration with Prof. James Lake, and worked for 2 month on a project titled "Rooting Large Genome Flows Deep Within Trees and Graphs". Since the project seemed very promising and the collaboration very productive, I went back next year, to do an internship and finish the work. The internship was financed by the NASA Planetary Biology Internship Program. The work hasn't been published yet, but it will be presented at the SMBE 2013 in August in Chicago. - Emiliano Pereira, Biomathematics, University of the Republic

I started two new collaborations: one with Paul Medvedev, Penn State, on new reference genomes, and the other with Alice McHardy, HHU Düsseldorf, on viral quasispecies. - Alexander Schoenhuth, CWI (Center for Mathematics and Computer Science)

I started collaborations with Louxin Zhang, National University of Singapore, and Jingyi Jessica Li, University of California, Berkeley.- Zhang, Shihua, Academy of Mathematics and Systems Science, Chinese Academy of Sciences

How has your participation in the program affected your career and research direction?

I was just starting my PhD when I came to the program, and I feel it introduced me to the field in a way that would otherwise have taken years. By this I refer both to familiarizing myself with some of the most influential topics and research questions, as well as to understanding what it actually means to be a researcher in this field. I think my participation greatly helped me to direct my efforts more efficiently towards that direction. - Yael Baran, Computer ScienceTel Aviv University

As a mathematician, I can now work on biologically-inspired themes and that I now know the right persons to direct my inquiries to. - Simon Foucart, Mathematics, Drexel University

Greatly. Apart from two fruitful collaborations, which are quite worthy on their own, I met with many of the major players in my field and got a much better view of the field, future challenges and interesting problems to work on. - David Golan, Statistics, Tel Aviv University

The program helped me reconnect with other more computational and mathematical bioinformaticists. That has helped me both with the faculty job search and with having collaborators with which to do the sort of sequencing work that I do. My research tends to be highly translational and it is important for me to sustain connections to collaborators that develop methods. I also met Elaine Mardis through the IPAM and she is an extremely pivotal contributor to cancer genomics. She has been mentoring me ever since. - Catherine Grasso, Pathology, University of Michigan

Participating in IPAM has helped me to jumpstart a new direction in my research. I left IPAM with new research questions and collaborators. Additionally, it helped me to understand the technology associated with new generations of high throughput data; of vital importance to statisticians who need to get all possible information out of the data. – Jo Hardin, Mathematics, Pomona College

This program allowed me to develop a deeper understanding of the "state of the field" for mathematical approaches to genomics and next-gen sequencing in particular. My research direction has become increasingly *-omics based as a result of attending this program. As for my career, this program provided me the networking opportunities to find my first postdoctoral position at Drexel University and indirectly assisted me in securing a tenure-track position at Oregon State. - David Koslicki, Mathematics, Oregon State University

My participation in the IPAM program had a very positive effect on my career. I met many top researchers in statistical genomics and computational biology. My conversations with them have provided me with new perspectives and broaden my visions into the field. - Jingyi Li, Biostatistics, University of California, Berkeley

The workshop (GEN2011) I attended in IPAM is absolutely an invaluable experience in my academic career. In the workshop, we presented our work about RNA-seq and our work attracted attention from researchers of many other institutes; the interaction with other speakers inspired many exciting research ideas. Greatly appreciated for IPAM hosts for the wonderful workshop and I look forward to similar workshops hosted by IPAM. - Wei Li, Computer Science and Engineering, University of California, Riverside

My visit to IPAM was a step towards building stronger statistical foundations for my research program, an ongoing development. - David Liberles, Department of Molecular Biology, University of Wyoming

Since IPAM, I have moved to an Assistant Professor position at Penn State. This is entirely due to discussions I had with Francesca Chiaromonte (another participant) during my stay at IPAM. She made me aware that there was a position available, encouraged me to apply, and hosted me for my interview. Through interactions with Catherine Grasso (another participant) during my stay at IPAM, we formed a collaboration which exposed me to the medical aspects of the field. This has been enlightening for me and has greatly influenced my research by directing to be more applicable in the medical community. Interactions with David Golan (participant) during my stay generated ideas that led to a joint paper. - Paul Medvedev, Computer Science and Engineering, University of California, San Diego

The contacts I made through the IPAM program have led to multiple scientific interactions including papers, conferences, and students. - Matteo Pellegrini, Molecular, Cell, and Developmental Biology, University of California, Los Angeles

My participation in GEN2011 was highly enriching. It fostered a collaboration and broadened my knowledge, experience and skills in bioinformatics. - Emiliano Pereira, Biomathematics, University of the Republic

The experience of participating in this program has expanded my research interests such as that about cancer genomics, helped me to build close connections with those who have common interests. - Shihua Zhang, Academy of Mathematics and Systems Science, Chinese Academy of Sciences

WORKSHOP: High-Throughput Genomics Tutorials. September 13 - 16, 2011

Organizing Committee:

Eleazar Eskin (University of California, Los Angeles (UCLA), Computer Science)
Matteo Pellegrini (University of California, Los Angeles (UCLA), Molecular, Cell, and Developmental Biology)
Sebastien Roch (University of California, Los Angeles (UCLA), Mathematics)

Scientific Overview:

Tutorials provided an introduction to several major research topics in the analysis of next-generation genomic sequence data. These topics include among others sequence alignment and assembly, analysis of RNA-seq and ChIP-seq data, modeling evolution of sequences, and studying population structures. The intent is to familiarize prospective participants with both the underlying biological context and common data analytic techniques.

WORKSHOP: Next-generation Sequencing Technology and Algorithms for Primary Data Analysis (Genomics Workshop I). October 3 - 6, 2011

Organizing Committee:

Phil Green (University of Washington)
Matteo Pellegrini (University of California, Los Angeles (UCLA), Molecular, Cell, and Developmental Biology)
Aviv Regev (Broad Institute)
Eric Schadt (Pacific Biosciences)
Jay Shendure (University of Washington)
Yun Song (University of California, Berkeley (UC Berkeley))

Scientific Overview:

In just a few years, new technologies for massively parallel DNA sequencing have become widely available, reducing the cost of sequencing a genome by four orders of magnitude and placing the capacity to generate gigabases to terabases of sequence data into the hands of individual investigators. These “next-generation” technologies have the potential to dramatically accelerate biological and biomedical research by enabling the comprehensive analysis of genomes and transcriptomes to become inexpensive, routine and widespread.

This is a dynamic moment in the field. The technologies themselves are evolving at a breathtaking pace, and the exploding volume of data has spurred the development of novel algorithmic approaches for primary analyses of sequence data.

Leaders in the field presented next-generation sequencing technology and discussed the various mathematical and computational challenges presented by these technologies. The workshop provided an introduction to the core concepts driving the development of leading second-generation and third-generation technologies. This discussion was linked to an extensive consideration of methods for base-calling and variant-calling, for aligning reads to reference sequences (e.g. genomes) and for de novo assembly of short reads into longer sequences.

WORKSHOP: Future Directions in Mathematics (with Department of Defense). October 12-14, 2011

Organizing Committee:

Russel Caflisch, UCLA
Robert Kosut, SC Solutions
Stanley Osher, UCLA

Scientific Overview:

The Office of the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)) within the Department of Defense invited IPAM to hold a workshop to discuss opportunities and future directions in mathematics. The conference convened 23 leaders in the field from academia and industry (and four government observers) who provided perspectives on potential breakthroughs and barriers to advancement in the rapidly-changing field of mathematics. The goal was ensure that current scientific understanding at ASD(R&E) is informed by farsighted advice and expertise external to DoD.

Some of the topics covered in the workshop were:

- Reduced order modeling
- Imaging science
- Machine learning
- Materials design
- Network analysis/graph theory/multi-agent systems
- Optimization
- Cryptography
- Control, especially robust control
- Harmonic analysis and its applications
- Computational E&M
- Quantum information and control

The workshop addressed the following questions:

- What have been the major breakthroughs in mathematics over the last decade?
- What new areas do you see emerging in the next decade?
- What accomplishments or capabilities will be attainable in 5 years? 10 years?
- Are there particular infrastructure needs that the DoD should be investing in?
- Where are existing and emerging global centers of excellence in mathematics?
- What are the most important efforts for DoD to support in the next decade?

After the workshop, the organizers prepared a 20 page report summarizing the event's structure, participants, findings, and recommendations for the Department of Defense. It offered a synthesis of forward-looking projections of the future of mathematics, including recent accomplishments, expected challenges, and an analysis of the infrastructure.

REUNION CONFERENCE: Networks and Network Analysis for the Humanities. October 20-22, 2011.

Organizing Committee:

Tim Tangherlini (UCLA)
Russ Caflisch (IPAM)
Tina Eliassi-Rad (LLNL)
Peter Jones (Yale)
Mark Green (UCLA)
Ronald Coifman (Yale)
Jonathan Berger (Stanford)
Lewis Lancaster (Berkeley)
Greg Crane (Tufts)

Scientific Overview:

This was a reunion or follow-up meeting for participants of the Digital Humanities Summer Institute, held at IPAM in August 2010. The Institute and this meeting were funded by the National Endowment for the Humanities as part of their Institutes for Advanced Topics in Digital Humanities program**.**

The main goal of the Institute was to teach Humanities scholars some of the methods to study networks. It addressed: (a) the science of networks and networks in Humanistic inquiry (b) preparing and cleaning Humanities data for network analysis (c) internal networks in Humanistic data: networks of characters, networks of texts, networks of language (d) external networks in Humanistic data: networks of influence, networks of production, networks of reception. At the follow-up meeting, each participant presented their research since attending the Institute, and demonstrated how they incorporated network analysis in their work.

WORKSHOP: Transcriptomics and Epigenomics (Genomics Workshop II). October 25 - 28, 2011

Organizing Committee:

Sandrine Dudoit (University of California, Berkeley (UC Berkeley), Biostatistics and Statistics)
Lior Pachter (University of California, Berkeley (UC Berkeley), Mathematics)
Matteo Pellegrini (University of California, Los Angeles (UCLA), Molecular, Cell, and Developmental Biology)
Barbara Wold (California Institute of Technology, Biology Division)
Wing Wong (Stanford University, Statistics)

Scientific Overview:

The set of RNA transcripts in cells, collectively referred to as the transcriptome, are of fundamental importance as they form the substrate for protein synthesis, while also having the ability to assume functional roles via their secondary and tertiary structure. Transcriptional regulation is frequently controlled epigenetically, i.e. via mechanisms that do not depend strictly

on the underlying DNA sequence. The collection of epigenetic marks is known as the epigenome.

Close connections between the transcriptome and epigenome are beginning to be unraveled via new technologies based on high-throughput sequencing that allow for the measurement of the transcriptome and epigenome at the resolution of individual nucleotides. For example, using RNA-seq it is possible to obtain a comprehensive and quantitative view of the cellular transcriptome. The measurement of the epigenome includes the profiling of cytosine metylation in the entire genome using approaches known as BS-seq or MethylC-seq. Protein DNA interactions also play a critical role in epigenetic regulation and chromatin-immunoprecipitation may be used to identify binding sites for specific proteins, using an approach termed ChIP-seq. Much work has already been dedicated to mapping histone modifications across the genome and thus elucidating the "histone code". Furthermore, nucleosome positions are also important in regulating transcription and replication, and these can be measured using nuclease-based assays. As the epigenome of each type of cell is different, profiling epigenomes from stem cells to differentiated cells presents a daunting challenge for the genomics community.

The analyses of these types of data are presenting the mathematical community a rich set of challenges. These include the development of algorithms for read mapping, transcript assembly, peak calling, and prediction of nucleosome positions from the DNA sequence of the genome. All of these problems require the development of novel statistical and computational techniques, and mathematical foundations for many of the ideas need to be developed.

The workshop presentations discussed the mathematical challenges in each of these fields.

WORKSHOP: NSF Mathematics Institutes' Modern Math Workshop (at SACNAS).
October 26 - 27, 2011

Organizing Committee:

Ricardo Cortez (Tulane University)
Suzanne Lenhart (University of Tennessee)
Christian Ratsch (Institute for Pure and Applied Mathematics, Associate Director)
Ivelisse Rubio (University of Puerto Rico, Computer Science)

Scientific Overview:

The eight NSF mathematics institutes offered three concurrent sessions immediately preceding the SACNAS annual meeting – one for graduate students and recent PhDs, and two for undergraduate students – to invigorate the research careers of minority mathematicians and mathematics faculty at minority-serving institutions. The "Modern Math Workshop" highlighted the institutes' upcoming programs, and offered a keynote address and an informative panel presentation on the institutes' programs and workshops. The two undergraduate sessions (applicants chose one) were appropriate for students of any major interested in how mathematics contributes to our understanding of various scientific topics. Activities included lectures and group work.

The three sessions came together for the keynote lecture by Ivelisse Rubio entitled "Solvability of diagonal equations over finite fields."

The graduate student session (also including recent PhDs) featured 40-minute presentations by eight speakers, one on behalf of each institute. The speakers gave "accessible" presentations on exciting and current research topics associated with the upcoming institute programs. An informational panel of institute representatives described upcoming programs and other opportunities offered by the institutes and how to participate in them.

Two minicourses for an undergraduate audience were offered at the same time. Applicants chose one of the following.

1) *Optimal Control of Ordinary Differential Equations*
   Suzanne Lenhart, whose main research area is optimal control applied to biological models, presented introductory material on optimal control for ordinary differential equations. The basic idea is to find optimal 'controls' (types of coefficients or source terms) in ordinary differential equations to achieve a goal (like minimizing infecteds in a disease model). After giving some background on the theory and basic techniques, students were asked to solve a simple problem in groups and to formulate a more complicated problem for a model of their own interest. The course also included demonstrations of examples using user-friendly MATLAB codes. Suzanne Lenhart is a mathematics professor at Univ. of Tennessee and is the Associate Director for Education, Outreach and Diversity at the National Institute for Mathematical and Biological Synthesis.

   2) Counting Lattice Points in Polytopes
   A polytope is the higher-dimensional generalization of a polygon. After Federico Ardila presented some background, he introduced the problem of "measuring" a polytope by counting the lattice points inside it, a problem that occurs very naturally in several areas of mathematics. Federico Ardila is an assistant professor at San Francisco State University. His research studies objects in algebra, geometry, topology, and applications by understanding their underlying combinatorial structure. He leads the SFSU–Colombia Combinatorics Initiative.

WORKSHOP: Cancer Genomics (Genomics Mini-Workshop). October 31 - November 1, 2011

Organizing Committee:

Stanley Nelson (University of California, Los Angeles (UCLA), Human Genetics)
Ben Raphael (Brown University)
Jasmine Zhou (University of Southern California (USC))

Scientific Overview:

The recent development of high-throughput genomics technologies has enabled researchers to take a comprehensive and high-resolution view of the genetic and epigenetic changes present in cancer cells. These include changes in DNA sequence and organization, DNA copy number, gene and microRNA expression, alternative splicing, DNA methylation, and histone modifications. Cancer genomics, the comprehensive study of genomic abnormalities that promote cancer development, has exploded as a field. Detailed catalogues of cancer genomic information have already revolutionized our understanding of the mechanisms behind

pathogenesis and progression. However, the rapid accumulation of genomics data has not been fully utilized; and successful translation into meaningful clinical end points has proven difficult. We are faced with an urgent challenge: how best to integrate, model, and exploit the abundance of complex, multi-dimensional cancer genomics data.

The workshop involved experts in computational, mathematical, and systems biological methods for deciphering the cancer diseases. Recent technological and methodological developments have led to exciting discoveries. Current challenges in the field of cancer genomics were presented.

WORKSHOP: Evolutionary Genomics (Genomics Workshop III). November 15 - 18, 2011

Organizing Committee:

Cedric Chauve (Simon Fraser University)
Scott Edwards (Harvard University)
Daniel Huson (Eberhard-Karls-Universität Tübingen)
James Lake (University of California, Los Angeles (UCLA), MBI, MCDB, Human Genetics)
Sebastien Roch (University of California, Los Angeles (UCLA), Mathematics)

Scientific Overview:

The study of evolution is being transformed by advances in next-generation sequencing technologies. Evolutionary biologists are facing major computational and statistical challenges in the analysis of such massive datasets as whole genomes from multiple species, genomic variation within populations, genome-wide expression data, and environmental samples. Experts from biology, mathematics, and computer science came together to survey ongoing developments in evolutionary genomics and foster collaborations across these fields. Topics included genome evolution, comparative genomics, phylogenomics, tree of life projects, and metagenomics.

WORKSHOP: Coancestry, Association, and Population Genomics (Genomics Workshop IV). November 29 - December 2, 2011

Organizing Committee:

Carlos Bustamante (Stanford University)
Eleazar Eskin (University of California, Los Angeles (UCLA), Computer Science)
Steve Evans (University of California, Berkeley (UC Berkeley), Statistics)
Phil Green (University of Washington)
Elizabeth Thompson (University of Washington)

Scientific Overview:

Statistical and population genetics have always been rich in mathematical challenges. The recent availability of sequence from 1000s of human genomes, only increases these challenges. These data provide unprecedented opportunity to analyze the structure of the human population and understand how genetic variation affects traits. Increasingly, recent studies show that the genomes of modern individuals are shaped by many forces including complex patterns of ancestry from multiple ancestral populations, ancient migration patterns and spatial structure of human population. This sequence data provides opportunities to study, model, and analyze the

complex genetic structure of the human population and the processes of mutation and selection that have established and maintain human variation. Increasingly, inherited variants of interest are not simply DNA base changes, but include copy-number variants (small duplications or deletions), inversions, and the products of gene conversion.

Over the last few years, Genome Wide Association Studies (GWAS) have been a central tool for elucidating the connections between genetic variation and traits. While in the past the genetic variation has consisted of Single Nucleotide Polymorphism arrays (which collect only the common variants), in the coming years this will likely switch to whole genome sequencing which will provide the opportunity to understand how rare variation affects traits.

This workshop focused on mathematical challenges in analyzing human variation data and its affect on traits both from sequences and SNP arrays. Topics included mathematical, statistical and computational challenges in modeling human populations and admixture, spatial population structure, as well as development of techniques for analysis of genome-wide association studies, gene-gene interactions, gene-environment interactions, and rare variation effects on traits.

PUBLIC LECTURE: Interpreting Personal Genomes: Promises and Potential Pitfalls.
Tuesday, November 29, 2011.

Presented by Carlos D. Bustamante, PhD, professor of genetics, Stanford University School of Medicine.

Abstract:

Understanding the relative effects of different population genetic forces on the apportionment of human genomic variation is a central focus of medical and population genomics. Much of what we know comes from analyzing patterns of common, and, therefore, ancient genetic polymorphisms via genotyping across diverse human populations. Recent studies have used sequencing approaches to reveal a more complete and genome-wide picture of variation, including lower frequency variants with a more recent evolutionary origin. In this talk, Bustamante presented a systematic analysis of 50 human genomes from 11 diverse global populations, sequenced at high coverage. The sample included 12 individuals of admixed ancestry that have varying degrees of recent (within the last 500 years) African, Native American, and European ancestry. Using approaches for modeling population history that consider sequence diversity and the length distribution of segments of continuous inferred ancestry, Bustamante and his team of researchers reconstructed shared and unique aspects of population demographic history based on singly sequenced human genomes that recapitulate extreme bottlenecks at the Out-of-Africa event as well as during the peopling of the Americas.

Speaker Bio:

Carlos Bustamante is a population biologist who mines DNA sequence data for insights into the dynamics and migration of populations and the mechanisms of evolution and natural selection. Bustamante received an MS in statistics and a PhD in biology from Harvard University. He held positions at the University of Oxford (2001–2002) and Cornell University (2002–2009) prior to his appointment as a professor of genetics at the Stanford University School of Medicine. Bustamante received a MacArthur Fellowship in 2010.

WORKSHOP: Mathematics of Traffic Flow Modeling, Estimation and Control. December 7 - 9, 2011

Organizing Committee:

Alexandre Bayen (University of California, Berkeley (UC Berkeley))
Helene Frankowska (Centre National de la Recherche Scientifique (CNRS))
Jean-Patrick Lebacque (IFSTTAR/GRETTIA)
Benedetto Piccoli (Rutgers University-Camden)
Michael Zhang (University of California, Davis (UC Davis))

Scientific Overview:

Traffic congestion has a significant impact on economic activity throughout much of the world. An essential step towards active congestion control is the creation of accurate, reliable traffic monitoring and control systems. These systems usually run algorithms which rely on mathematical models of traffic used to power estimation and control schemes.

Modeling: The workshop will span the large variety of models currently used in traffic flow modeling, from the seminal first order hyperbolic conservation law (Lighthill Whitham Richards) to more sophisticated models (such as systems of conservation laws) and integral forms of the Hamilton Jacobi type. The models will be compared, and the state of the art discussed (some existence and uniqueness questions on networks of such PDEs, which appear naturally in engineering are still open problems). In addition, models capable of encompassing traffic variability and uncertainty will be investigated. Numerical analysis contributions for efficient solutions to these PDEs will be outlined as well, starting from the seminal Godunov schemes to more modern schemes currently used for second order traffic models and Hamilton-Jacobi equations.

Estimation: Estimation is key to any control scheme for highways and arterials, since traffic operations systems rely on real-time knowledge of the state of traffic. Performing estimation on PDEs or numerical approximations of PDEs is hard. Working on the PDEs directly implies the construction of observers on hyperbolic conservation laws with discontinuous solutions, a problem which is still open for networks. Working on their finite difference approximations is also hard, because of the non-differentiability of schemes, which makes it necessary to use statistical methods such as particle filters or ensemble Kalman filters. The workshop will focus on two aspects key to estimation: the construction of estimation algorithms for stochastic models of traffic, stochastic approaches (such as Kalman filtering and its extensions) to discretized [deterministic] flow models.

Control: The control of traffic flow suffers from the same challenges as estimation, as typically the control schemes used will have to deal with non-smoothness of the solutions, making the use of adjoint based techniques challenging. The workshop will review techniques which have been used in the past, mainly for discrete approximation of these equations, and will outline the open questions when trying to extend these to the continuous representations of traffic such as PDEs. Finally, the application of optimal control schemes to stochastic models of traffic can be investigated as well.

Experts from various domains ranging from transportation engineering to mathematics (which span the three topics above) participated in this workshop.

WORKSHOP: Genomics Culminating Workshop at Lake Arrowhead. December 11-16, 2011

The culminating workshop was organized by the long program organizing committee.

The final workshop in the long program, held at Lake Arrowhead Conference Center, provided an opportunity for the program's core participants to report on their work during the past three months and to discuss future projects. Many of the collaborations and interactions that were formed during the program had a chance to deepen.

REUNION CONFERENCE: Climate Modeling Reunion at Lake Arrowhead Conference Center. December 11 - 16, 2011

This was the first reunion conference for participants of the spring 2010 long program "Model and Data Hierarchies for Simulating and Understanding Climate." It was a timely get-together to continue some of the collaborations that were started during the long program. Presentations were given by all participants, with plenty of time between talks for discussions and collaborations.

REUNION CONFERENCE: Kinetic Transport Reunion at Lake Arrowhead Conference Center. December 11 - 16, 2011

This was the second reunion conference for participants of the spring 2009 long program "Quantum and Kinetic Transport: Analysis, Computations, and New Applications." It was a timely get-together to continue some of the collaborations that were started during the long program and at the first reunion. Presentations were given by all participants, with plenty of time between talks for discussions and collaborations.

WORKSHOP: Large Scale Multimedia Search. January 9 - 13, 2012

Organizing Committee:

Juan Bello (New York University)
Samy Bengio (Google Inc.)
Ronald Coifman (Yale University)
Kristen Grauman (University of Texas at Austin)
Yosi Keller (Bar-Ilan University, electrical Engineering)
Yann LeCun (New York University)
Cordelia Schmid (INRIA)

Scientific Overview:

The proliferation of digital multimedia data has fundamentally changed the way images, video, audio and three-dimensional data are stored and used. The huge and ever growing volume of data in online repositories such as YouTube and Flickr requires novel approaches to content based multimedia search and retrieval. The workshop brought together an interdisciplinary community from mathematics, computer vision, computer audition, engineering and machine learning to

present and discuss the different facets of this problem. We discussed both domain specific issues and broader topics in machine learning and large-scale computational schemes, such as metric learning, 'learning to rank' and nearest neighbors search in high dimensions.

WORKSHOP: Mathematical Challenges in Graphical Models and Message-Passing Algorithms. January 23 - 27, 2012

Organizing Committee:

David Gamarnik (Massachusetts Institute of Technology, Sloan School of Management)
Andrea Montanari (Stanford University)
Devavrat Shah (Massachusetts Institute of Technology)
Prasad Tetali (Georgia Institute of Technology)
Rüdiger Urbanke (EPFL (Ecole Polytechnique Fédérale de Lausanne))
Martin Wainwright (University of California, Berkeley (UC Berkeley))

Scientific Overview:

Graphical models are used and studied within a variety of disciplines of computer science, mathematics and statistics. This meeting highlighted various mathematical questions and issues associated with graphical models and message-passing algorithms, and convened a group of researchers for discussion of the latest progress and challenges ahead.

In addition to the substantial impact of graphical models in applied areas, graphical models also are connected to various branches of the mathematical sciences. Rather than focusing on the applications, this meeting highlighted and deepened these mathematical connections. Given the range of these connections, the area has great promise for growth.

More concretely, the past decade has witnessed exciting interplay between graphical models and the following branches of the mathematical sciences:

- Probabilistic methods and combinatorics: theory of weak convergence of sparse graphs (objective method); interpolation method; techniques to establish sharp thresholds for monotone properties.
- Statistical physics: belief propagation, cavity method, Bethe approximation, phase transitions, spatial and temporal correlation decay, mathematical methods for spin glass theory.
- Optimization and convex relaxations: Message-passing and linear programming relaxations; variational methods and marginal polytopes.
- Computation and theory of algorithms: Markov chain Monte Carlo algorithms; derandomization of counting algorithms; distributed computation.
- Coding theory: random code constructions, message-passing decoding, density evolution, expander graphs.
- Statistics and machine learning: inference in large scale data models

WORKSHOP: Challenges in Synthetic Aperture Radar. February 6 - 10, 2012

Organizing Committee:

Brett Borden (Naval Postgraduate School)
Margaret Cheney (Rensselaer Polytechnic Institute, Mathematical Sciences)
Scott Hensley (Jet Propulsion Laboratory)
Eric Mokole (United States Naval Research Laboratory)
George Papanicolaou (Stanford University, Mathematics)
Edmund Zelnio (Air Force Research Laboratory)

Scientific Overview:

This interdisciplinary workshop addressed challenging problems in radar imaging. The following issues were explored:
1. Exploiting data from multiple viewpoints to obtain three-dimensional information;
2. Forming images of challenging targets, such as moving targets, non-rigid targets, or targets that scatter weakly;
3. Exploiting prior information and properties such as sparsity to improve image formation;
4. Forming images through complex media, and;
5. Including more sophisticated target modeling, such as multiple scattering, polarimetric scattering, and stochastic target models, in the image formation process.

Comment from a participant:

"This meeting was so constructive because it combined applications-oriented top flight engineers with very strong interested mathematicians. I believe this symposium will measurably stimulate progress in radar in the coming five to seven years …. I know that our young soldiers are protected when they can see hostile settings in advance of plunging into them. This is one key use of synthetic aperture radar… For me, the topic of concern in this meeting is and will continue to be of vital concern." Richard Albanese, retired, Air Force Research Labs, San Antonio

WORKSHOP: Nonlocal PDEs, Variational Problems and their Applications. February 27 - March 2, 2012

Organizing Committee:

Luis Caffarelli (University of Texas at Austin)
Rustum Choksi (McGill University)
Luis Silvestre (University of Chicago)
Dejan Slepcev (Carnegie-Mellon University)
Luminita Vese (University of California, Los Angeles (UCLA), Mathematics)

Scientific Overview:

The last decade has seen vigorous research activity to understand systems involving long-range effects, and to directly incorporate such effects in the modeling and analysis. This research has

led to fundamental questions about several classes of nonlocal partial differential equations (PDEs), such as their long-time existence and regularity. Examples discussed in this workshop include the following:

(a) long-range effects that lead to pattern formation in a large number of physical systems;
(b) large scale behavior of groups of animals that lead to the so- called aggregation equations with nonlocal transport terms;
(c) models of the surface temperature of the oceans that lead to equations with nonlocal diffusion due to atmospheric effects;
(d) the use of nonlocal diffusions and energies in image processing.

This workshop brought together both pure and applied mathematicians with a focus on (i) partial differential equations with nonlocal diffusive and/or transport terms, and their probabilistic interpretations (ii) nonlocal problems in pattern formation and phase transitions and biology, and (iii) nonlocal techniques in image processing.

LONG PROGRAM: Computational Methods in High Energy Density Plasmas. March 12 - June 15, 2012

Organizing Committee:

Christina Back (General Atomics)
Andrew Christlieb (Michigan State University, Mathematics)
Jill Dahlburg (United States Naval Research Laboratory)
Michael Desjarlais (Sandia National Laboratories)
Frank Graziani (Lawrence Livermore National Laboratory)
Leslie Greengard (New York University)
David Levermore (University of Maryland, Department of Mathematics)
Warren Mori (University of California, Los Angeles (UCLA), Physics/Engineering)
Michael Murillo (Los Alamos National Laboratory)

The program involved a community of senior and junior researchers. Most participants were in residence at IPAM continuously for the fourteen weeks. The program opened with tutorials, followed by four major workshops, a one-day "mini-workshop," and a culminating workshop at UCLA's Lake Arrowhead Conference Center. Between the workshops there was series of seminars and collaborative activities involving the long-term and short-term participants, as well as visitors.

Full and partial support for participation was awarded. Support for individual workshops was also available. Recent PhD's, graduate students, and researchers in the early stages of their career were especially encouraged to apply.

Scientific Overview:

High energy density physics (HEDP) is a rapidly growing field. HEDP conditions are typically from Mbar to tens of Gbar pressures and temperatures ranging from eV to GeV. These are the conditions seen in the interiors of Jovian planets, the core of the sun, Tokamaks and matter in the early stages of the universe. With the advent of experimental platforms like the Linear Coherent Light Source (LCLS), the National Ignition Facility (NIF), pulse power and the Relativistic Heavy Ion Collider (RHIC), the scientific community is beginning to obtain high quality data of

matter at extreme conditions. In addition, new high performance computing hardware is providing exciting new massively parallel platforms that enable higher fidelity simulations.

This long program focused on the computational approaches to the modeling of these extreme states of matter. It will address the scientific challenges facing the computational HEDP community and discuss the successes and failures of various methods. Algorithmic approaches such as Particle-In-Cell, Molecular Dynamics, Wave packet Molecular Dynamics and Wigner Trajectories will be compared and contrasted. The computer science challenges of writing and running massively parallel simulations is critical to the success of being able to simulate the various HEDP phenomena.

The technical goals of the program were:

- Identify key application drivers in computational HEDP
- Assess the state of the art with regards to computational HEDP
- Identify the grand challenges facing the field over the next 5-10 years
- Identify key experimental data needs
- Social goals of the program
- Open up lines of communications between researchers in computational HEDP
- Establish new collaborations
- Foster cross fertilization between different fields

We conducted anonymous pre- and post-surveys of "Plasma" participants. The results of the surveys help us measure the success of the program as well as help us address weaknesses. Here are some comments from the surveys:

- I was looking forward to this program for over a year, and it exceeded all my expectations. It comes at a critical point in my professional development; I completed my dissertation on extended-moment modeling of magnetic reconnection in Sept and will begin a post-doc in PIC simulation of reconnection in Sept, and this workshop has provided me with an abundance of resources and connections to aid me in the transition. I have been struggling to straddle the numerics and plasma communities for a long time, and this workshop brought those two communities together in a way unlike anything I had previously experienced. I have felt as if the program had been designed for me.
- I formed many valuable connections with other researchers that I expect will be long-lasting.
- Throughout this program I have been able to interact with both more junior and senior researchers, and in all cases I have come away with something positive from the exchange. Moreover, I hope/expect that this will mark the beginning of new collaborations.
- The time between talks when we could discuss was one of the best things about the program. I really appreciate that you post talk slides on your website.

In addition, we conducted a survey of participants in April 2013. Here are selected responses to the following two questions:

Please briefly describe any collaborations which grew out of your stay at IPAM:

Initiated collaborations with Bedros Afeyan and Eric Sonnendrucker on Vlasov-Landau-Fokker-Planck modeling. - Leslie Greengard, New York University

How has your participation in the program affected your career and research direction?

The discussions and reports show a wonderful future in the field of high energy density physics, therefore give me strong confidence to do more and extensive researches. Furthermore, the program also gathers most of experts in this field, showing their recent progress, and gives us the direction to do the next work. Finally, the friendship between the participants will be forever and the collaborations will be more and more. - Jiayu Dai, Department of Physics, National University of Defense Technology

I have suggested a research proposal for a Belgian return grant entirely based on higher moment models for plasmas.. I would move to the group of Prof. Giovanni Lapenta and Dr. Alec Johnson (Center for Mathematical Plasma Astrophysics). Participation in the IPAM workshop allowed me to take the time to work in this new field. - Peter Delmont, RWTH Aachen

A new book containing review articles on warm dense matter physics is an outgrowth of the IPAM Long program. - Frank Graziani, Lawrence Livermore National Laboratory

Participation helped focus research directions in my own group related to plasma physics. - Leslie Greengard, New York University

Through my stay at IPAM I got a much broader overview of physical phenomena, latest developments and the tools and techniques used in related fields to my own research direction. I am planning to keep contact to the other participants. Many valuable notes from the talks, suggestions by colleagues and ideas influenced by the discussions will enter my future research (and have already entered a proposal for a new research plan). - Patrick Ludwig, Institut für Theoretische Physik und Astrophysik, Christian-Albrechts Universität Kiel

My participation has definitely affected my research. I'm a mathematician and during my participation in the program I had the opportunity to interact with researchers from different backgrounds and institutions. In particular I learned new problems and physical models in the workshops and seminars celebrated during the program. The presentations of (and interaction with) physicists coming from the National Labs were revealing. The weekly Multifluids working group organized by Tim Barth (NASA) was also a good source for the learning process on new and different techniques that I'm currently using in my research. - Susana Serna, Mathematics, Autonomous University of Barcelona

Coupling models of interacting physical phenomena (for example, a radiation diffusion model and a hydrodynamics model) usually involves an operator splitting in which the order of execution is serialized, and the partial time advance is selected for converge and stability criteria. Discussions at IPAM has prompted me to start a project to re-examine the choice of operator splitting so that the two models could be run concurrently, and an iterative scheme applied: the open question is the overall effect on stability and convergence. - Bert Still, Lawrence Livermore National Laboratory

I came away from the IPAM experience with a much better sense of where our group's work fits, where we have opportunities (and even advantages) and what some likely dead ends are. - Samuel Trickey, University of Florida

Participation in the program has allowed me to establish invaluable connections, especially with computational scientists working at NIF. As such, I was able to forge new contacts in my field of study, and I believe these will be indispensable as I continue my career beyond graduate school. - Genia Vogman, University of California, Berkeley (UC Berkeley)

The plasma physics is a totally new area to me. It's a good topic where I can apply what I have learned before in math. It is a new and exciting research direction to me. - Bokai Yan, Mathematics, University of Wisconsin-Madison

WORKSHOP: Computational Methods in High Energy Density Plasmas: Tutorials. March 13 - 16, 2012
Organizing Committee:

Andrew Christlieb (Michigan State University, Mathematics)
Jill Dahlburg (United States Naval Research Laboratory)
Michael Desjarlais (Sandia National Laboratories)
Frank Graziani (Lawrence Livermore National Laboratory)
Leslie Greengard (New York University)
Warren Mori (University of California, Los Angeles (UCLA), Physics/Engineering)
Michael Murillo (Los Alamos National Laboratory)

Scientific Overview:

The long program opened with four days of tutorials that provided an introduction to major themes of the entire program and the four workshops. The goal was to build a foundation for the participants of this program who have diverse scientific backgrounds that range from physics to mathematics and computational sciences.

WORKSHOP: Computational Challenges in Hot Dense Plasmas (Plasma Workshop I). March 26 - 30, 2012

Organizing Committee:

Christina Back (General Atomics)
John Castor (Lawrence Livermore National Laboratory, Physics)
Frank Graziani (Lawrence Livermore National Laboratory)
Denise Hinkel (Lawrence Livermore National Laboratory)
David Levermore (University of Maryland, Department of Mathematics)
Vyacheslav Lukin (United States Naval Research Laboratory)
Igor Sokolov (University of Michigan, AOSS)

Scientific Overview:

The physics of hot, dense plasmas is a field rich with physics and mathematics, spanning many different length and time scales. To accurately simulate hot, dense plasmas requires resolving the physics of hydrodynamics, radiation and electron transport, atomic physics, burn physics, wave-wave interactions, wave-particle interactions and particle-particle interactions, to name a few processes.

To perform such a calculation that resolves such physics at all these length and time scales remains computationally unfeasible even with an exascale capability. Thus, it is important to differentiate between the physics that must be fully resolved, and the physics that can be included with a reduced model description in a fully integrated simulation. These fully integrated simulations including reduced model descriptions can then be validated through experiment.

The goals of this workshop were:

- to identify key physics components in integrated simulations of hot, dense plasmas
- to identify critical computation issues at the different length and time scales
- to propose reduced model descriptions that can be experimentally validated
- to define experiments critical to an integrated simulation of hot, dense plasmas
- to promote new collaborations
- to engage young scientists

WORKSHOP: Computational Challenges in Magnetized Plasma (Plasma Workshop II).
April 16 - 20, 2012

Organizing Committee:

Jeff Candy (General Atomics)
Vincent Chan (General Atomics)
Jill Dahlburg (United States Naval Research Laboratory)
William Dorland (University of Maryland, Physics)
James Drake (University of Maryland, Physics)
Leslie Greengard (New York University)
Vyacheslav Lukin (United States Naval Research Laboratory)

Scientific Overview:

The workshop focused on accurate, effective simulation of critical science elements that elucidate grand scientific challenges in magnetized plasmas. Science elements included magnetic reconnection, multi-scale transport, plasma-material interaction, and wave-particle physics. Science driver challenges included particle acceleration during naturally occurring and laboratory reconnections; multiscale phenomena in rapidly varying boundary layers; thermal electron transport along and across magnetic fields; and wave-particle acceleration mechanisms. Examples of computational frontiers included applicability of massively scalable implicit time-advanced methods and, high order accurate spatial discretization methods for lab and space magnetized plasma simulations. The goal of the workshop was to identify promising approaches for achieving solution of grand challenge problems in magnetized laboratory and astrophysical/space plasmas and also cross-cutting areas with HEDP in both science,

mathematics, and computing, and for defining related validation requirements that are needed to test the simulation predictions.

Quote from a workshop evaluation, written by a postdoc in math or statistics:
"This workshop has been superb. I have spent the last few years trying to straddle the plasma and numerics communities, and this workshop has brought so many things together for me. It has helped me to formulate a coherent research path that I see bringing together my interest in higher-moment fluid modeling of magnetic reconnection with my post-doctoral project which will involved kinetic simulation. This workshop is making a critical difference for me as I transition from fluid to kinetic simulation. Thanks."

PUBLIC LECTURE: National Ignition Facility: Pathway to Fusion Ignition, Frontier Science and Clean Energy. Wednesday, April 18, 2012

Presented by Ed Moses, Principal Associate Director for the National Ignition Facility & Photon Science Directorate

Abstract:

The National Ignition Facility (NIF) at Lawrence Livermore National Laboratory is quickly evolving into the world's largest and most energetic laser with applications to strategic security, fundamental science and fusion energy. By concentrating intense laser energy into a mm-sized target, NIF can produce conditions that have never been created in a laboratory and emulate those in planetary interiors and stellar environments. Experiments have been completed in support of materials equation of state, materials strength and radiation transport in extreme temperature and pressure conditions. The National Ignition Campaign, an international effort pursued at the NIF, has the goal of achieving fusion ignition in the laboratory—the culmination of a 50-year quest. Achieving ignition will demonstrate the viability of inertial fusion energy as a clean source of energy. Dr. Moses described the unprecedented experimental capabilities of the NIF, its role in strategic security and basic science, and the pathway to achieving fusion ignition to create a clean energy future.

Speaker Bio:

Dr. Edward Moses is the Principal Associate Director at Lawrence Livermore National Laboratory, responsible for the National Ignition Facility and Photon Science organization. He is also the National Director of the National Ignition Campaign. Dr. Moses has a career in high technology and big science projects reaching back to 1980 which included using high power laser systems to study problems ranging from cancer to optics to fusion.

Dr. Moses has received many awards and honors, including the Jefferson Award for Public Service, the 2009 Edward Teller Medal, the Fusion Power Associates 2008 Leadership Award, the National Nuclear Security Administration Defense Programs Award of Excellence, the Memorial D.S. Rozhdestvensky Medal, and the R&D 100 Award. Dr. Moses is a member of the National Academy of Engineering and the California Council on Science and Technology, and a Fellow of the Optical Society of America, the AAAS, and SPIE. He holds patents in laser technology, inertial fusion energy, and computational physics.

WORKSHOP: Mathematical and Computer Science Approaches to High Energy Density Physics. May 7 - 11, 2012

Organizing Committee:

Andrea Bertozzi (University of California, Los Angeles (UCLA), Mathematics)
Andrew Christlieb (Michigan State University, Mathematics)
Phil Colella (Lawrence Berkeley Laboratory)
William Dorland (University of Maryland, Physics)
Leslie Greengard (New York University)
David Levermore (University of Maryland, Department of Mathematics)
Warren Mori (University of California, Los Angeles (UCLA), Physics/Engineering)
James Rossmanith (University of Wisconsin-Madison, Department of Mathematics)

Scientific Overview:

This workshop focused on the fundamental modeling challenges that arise when simulating high energy density plasmas, including aspects of classical magnetohydrodynamics, five and six-dimensional formulations of plasma transport theory, plasma-material interactions, and the design of robust analytic techniques for software verification. These are all "multi-physics" problems, involving electromagnetic interactions, turbulent fluid behavior, and both quantum mechanical and relativistic corrections. These problems are also "multi-scale", requiring multi-resolution/hybrid algorithms and sub-grid modeling. We also considered methods for the simulation of the governing integro-differential equations that scale with problem size and are suitable for high-performance computing, including exa-scale and peta-scale platforms. The workshop attempted to make the modeling challenges accessible to applied mathematicians and computational scientists with little or no prior experience in plasma physics.

WORKSHOP: One-Day Workshop on High Performance Computing. May 14, 2012

Organizing Committee:

Evan Johnson (University of Wisconsin-Madison, Mathematics)
Andreas Markmann (Yale University, Chemistry)
Noah Reddell (University of Washington, Aeronautics and Astronautics)

Scientific Overview:

The mini-workshop on High Performance Computing in High Energy Density Plasma Simulation brought together experts in scientific computing, modern computer architectures, and HEDP to discuss current simulation successes and strategies to succeed with future architectures. The disparate time and spacial scales at work in high energy density plasma present one of the most daunting simulation challenges in scientific computing. Workshop attendees discussed the current gap between HEDP problems of interest and simulation capabilities. Current capabilities are lacking due to both simulation code design and limitations of even the fastest super-computers. Four workshop speakers (Warren Mori, Victor Decyk, Jim Glosli, and Noah Reddell) addressed both of these areas, with several messages in common. Future supercomputing speed up will be achieved through massive increase in parallelism due to

increasing number of cores or computation units, rather than clock speed and number of compute nodes. Programming for these emerging architectures is more complex and can require new programming models and languages. Success is possible as demonstrated by several contemporary examples on some of the newest machines.

WORKSHOP: Computational Challenges in Warm Dense Matter. May 21 - 25, 2012

Organizing Committee:

Michael Desjarlais (Sandia National Laboratories)
Stephanie Hansen (Sandia National Laboratories)
Michael Murillo (Los Alamos National Laboratory)
Ronald Redmer (Universität Rostock)
Samuel Trickey (University of Florida)

Scientific Overview:

Warm Dense Matter (WDM) occupies a loosely defined region of phase space intermediate between solid, liquid, gas, and plasma, and typically shares characteristics of two or more of these phases. WDM is generally associated with the combination of strongly coupled ions and moderately degenerate electrons, and careful attention to quantum physics and electronic structure is essential. The lack of a small perturbation parameter greatly limits approximate attempts at its accurate description. Since WDM resides at the intersection of solid state and high energy density physics, many high energy density physics (HEDP) experiments pass through this difficult region of phase space. Thus, understanding and modeling WDM is key to the success of experiments on diverse facilities. These include the National Ignition Campaign centered on the National Ignition Facility (NIF), pulsed-power driven experiments on the Z machine, ion-beam-driven WDM experiments on the NDCX-II, and fundamental WDM research at the Linear Coherent Light Source (LCLS). Warm Dense Matter is also ubiquitous in planetary science and astrophysics, particularly with respect to unresolved questions concerning the structure and age of the gas giants, the nature of exosolar planets, and the cosmochronology of white dwarf stars.

The workshop explored established and promising approaches to the modeling of WDM, foundational issues concerning the correct theoretical description of WDM, and the challenging practical issues of numerically modeling strongly coupled systems with many degrees of freedom. The list of computational frameworks and methods discussed includes:

- Finite-Temperature Density Functional Theory, including Orbital-Free methods
- Quantum Monte Carlo, including Path Integral Monte Carlo
- Wave-Packet Molecular Dynamics
- Classical and Semi-Classical Molecular Dynamics

The goals of this workshop included fostering increased communication and new collaborations between mathematicians, computer scientists, and physicists; an assessment of the current state of the field and critical experimental tests; a deeper understanding of the formal theoretical and numerical issues concerning the modeling of warm dense matter; and attracting promising young researchers to this difficult and exciting field.

PUBLIC LECTURES: Green Family Lecture Series. May 29-31, 2012

Presented by Walter Kohn, Nobel Laureate, UC Santa Barbara.

Public Lecture: A World Predominately Powered by Solar and Wind Energy?
Tuesday, May 29, 2012

Research Lecture: Electronic Structure of Matter: Wave Functions and Density Functionals
Wednesday, May 30, 2012

Special Research Lecture: A Physicist's Approach to Macular Degeneration
Thursday, May 31, 2012

Speaker Bio:

Walter Kohn studied Mathematics and Physics at the University of Toronto. He then completed his Ph.D. in Nuclear Physics and a postdoctoral fellowship at Harvard University in 1948, followed by postdoctoral work at the Niels Bohr Institute in Copenhagen.

Kohn has made major contributions to the physics of semiconductors, superconductivity, surface physics and catalysis. He was the founding director of the Institute of Theoretical Physics at the University of California in Santa Barbara, which is one of the leading research centers in physics. He has received numerous awards including the Niels Bohr/Unesco Gold Medal, the United States National Medal of Science and the Richard Prange Prize. His role in creating Density Functional Theory, the most widely used theory of the electronic structure of matter, earned him the Nobel Prize in Chemistry in 1998. In recent years, he was an active member of the U.S. government's Basic Energy Science Advisory Committee and a consultant with the National Renewable Energy Laboratory. In 2005 he produced a documentary on solar power entitled "The Power of the Sun." Kohn currently works on Macular Degeneration, renewable energies and global warming.

WORKSHOP: High Energy Density Plasmas Culminating Workshop at Lake Arrowhead. June 10-15, 2012

The culminating workshop was organized by the long program organizing committee.

The final workshop in the long program, held at Lake Arrowhead Conference Center, provided an opportunity for the program's core participants to report on their work during the past three months and to discuss future projects. Many of the collaborations and interactions that were formed during the program had a chance to deepen.

REUNION CONFERENCE: Optimization Reunion at Lake Arrowhead Conference Center. June 10-15, 2012

This was the first reunion conference for participants of the fall 2010 long program "Modern Trends in Optimization and Its Application." It was a timely get-together to continue some of the collaborations that were started during the long program. Presentations were given by all participants, with plenty of time between talks for discussions and collaborations.

REUNION CONFERENCE: Combinatorics Reunion at Lake Arrowhead Conference Center. June 10-15, 2012

This was the second reunion conference for participants of the fall 2009 long program "Combinatorics: Methods and Applications in Mathematics and Computer Science." It was a timely get-together to continue some of the collaborations that were started during the long program and at the first reunion. Presentations were given by all participants, with plenty of time between talks for discussions and collaborations.

SUMMER PROGRAM: Research in Industrial Projects for Students (RIPS)-Hong Kong. June 10 - August 10, 2012

IPAM offered RIPS-Hong Kong for the second time in 2012. In collaboration with Hong Kong University of Science and Technology (HKUST), eight U.S. students and eight Hong Kong/Chinese students worked on cross-cultural teams on four projects, each sponsored by a company based in the region. The format of the program is the same as RIPS-LA.

RIPS students have offices on the HKUST campus. The HKUST math department provides technical support as well as some social activities, Cantonese lessons, and occasional guest lectures. Students stay in a residence hall on campus. IPAM covers the U.S. students' expenses including round-trip travel to Hong Kong, accommodations, and most meals. Students also received a stipend. English is the only language required for participation.

RIPS-Hong Kong 2012 Sponsors and Projects	
Sponsor	**Project Title**
BGI	The Genetic Basis for Metal Adaptation in *Daphnia*
Hong Kong Observatory	Developing an Automatic Parameter Tuning Tool (APTT) for Rainfall Nowcasting
Huawei	Improved Maximum Likelihood Detection in MIMO Systems
MetLife	Quantifying Operational Risk

Quotes from students:

The experience is unlike any other research experience. The project was interesting, and it was useful to see the industrial application of our academic skills. Working across cultures was eye-opening. - Raymond Perkins, Morehouse University

I believe that this was a once-in-a-lifetime opportunity for all of us … I am grateful that this research experience was available to undergraduates. - Karen Larson, Davidson College

[RIPS-Hong Kong] has helped give me insight into how research functions in an industry setting. I still don't know what I plan on doing when I graduate, but I know that industry research is very rewarding. - Aashish Gadani, University of Maryland

SUMMER PROGRAM: Research in Industrial Projects for Students (RIPS). June 24 - August 24, 2012

RIPS Program Director: Michael Raugh

The Research in Industrial Projects (RIPS) Program provides an opportunity for high-achieving undergraduate students to work in teams on a real-world research project proposed by a sponsor from industry or a national lab. Each RIPS team is comprised of four students, an academic mentor, and an industrial sponsor. The research problem is developed by the industrial sponsor in consultation with IPAM; it is always a real problem of serious interest to the sponsor and that offers a stimulating challenge to students. The students, with direction from their academic mentor and industrial sponsor, spend nine weeks learning about the problem, mastering the latest analytical approaches and techniques to solve it, and developing report-writing and public-speaking skills to be able to make professional presentations about the progress and results of their work to a scientific audience. Industry mentors provide regular contact between the team and the sponsor, monitoring and helping to guide student work. Ultimately, RIPS provides valuable real-world technical and managerial experience for students as well as valuable R&D for sponsors.

Projects are selected to have a major mathematical component and to be something that will pose an interesting challenge to talented undergraduates. Some new industrial sponsors join the RIPS Program each year and the same projects are never repeated.

RIPS-Los Angeles 2012 Sponsors and Projects	
Company/Organization	**Project Title**
Aerospace Corp	Regional Coverage from Space Systems
Arete	Optimal Digital Elevation Model (DEM) Estimation
HRL Laboratories	Information Theoretically Secure Computation Protocols in the Quantum Noisy Storage Model
IBM	Fast Approximation Algorithms for Spectral Clustering
Intel	Hetero-Crystal Generation from an existing Database
Los Angeles Police Department	How Low Can Crime Go? Measuring the Decline in Crime and Setting Realistic Crime Reduction Targets
Shoah Foundation Institute	Improving Cross-lingual Search Quality
Standard & Poor's	Pricing and Risk in the Credit Markets: Investigation of Credit Default Swaps
Symantec	Optimization of the Cybersecurity TRIAGE Method for Real-world Criminal Events

Anonymous comments from post-program surveys:

- I discovered how much fun doing research full time is and I'm really looking forward to graduate school and potential career in academia.
- This has definitely been an eye opener. You always hear about how you can apply math anywhere but to experience it first hand is another thing entirely. It was great to not only work on an application but to see the other team's work unfold.
- This program definitely opened up new opportunities to my eyes. I learned a lot!
- The emphasis on writing proposals, reports and giving presentation was really helpful. Definitely one of the strongest parts of the program.
- I found my experience in research this summer very rewarding.

Comments from students by name:

RIPS offers an experience which is more mathematically-oriented than any internship and more application-oriented than any pure research program. To my knowledge, there's no equivalent. - Clark Bowman, University of Rochester

More than anything RIPS gave me glimpse into what research is like. I loved being able to focus on a particular problem and see how I could synthesize what I've learned before to solve the problem. RIPS sort of confirmed my plans to go to graduate school. - Sameer Deshpande, MIT

RIPS exposed me to a new way of looking at mathematics. My classroom education now seems to have so much more value. I've learned so much about different fields of math and about myself. - Sasha Matthews, Florida A&M University

What you experience throughout the program and the skills and tools you gain are of immense value. I never thought I could learn so much about a topic and myself in just nine weeks. - Vanessa Rivera Quinones, University of Puerto Rico

In addition, here are responses from two RIPS 2011 students, describing how their participation in RIPS influenced their careers and interests. The survey was conducted in May 2013, almost two years after the program.

My participation in RIPS enabled me to see the applied aspect of my research and to further understand my interests. Back then I was a sophomore wondering if I should pursue applied mathematics as a career path. Now, I am a graduating senior, and I have been admitted to University of Michigan and University of Minnesota, to study a PhD in applied mathematics. My career goal is to become a Professor. My participation in RIPS was a great learning experience and it certainly encouraged me to continue down this path. - Mauricio Flores, University of Texas at Brownsville

It definitely opened my eyes to the world of industrial research. It changed my career path to work on problems that have a real life impact. Also, since I liked my experience so much at RIPS, I took part in another research program last summer. - Olivier Mercier, University of Montreal

SUBWORKSHOP: RIPS 2012 Projects Day. August 18, 2012

Organizing Committee: N/A

The nine RIPS-LA teams presented their industry-sponsored research on the projects listed above. Representatives of the industry sponsors attend, and the event was open to the public. Prospective RIPS students, math and science majors, family members of the students, and others in UCLA's math and science community attended.

SUMMER PROGRAM: Graduate Summer School: Deep Learning, Feature Learning. July 9 - 27, 2012

Organizing Committee:

Yoshua Bengio (University of Montreal, Canadian Institute for Advanced Research)
Geoffrey Hinton (University of Toronto, Canadian Institute for Advanced Research)
Yann LeCun (New York University, Canadian Institute for Advanced Research)
Andrew Ng (Stanford University, Canadian Institute for Advanced Research)
Stanley Osher (University of California, Los Angeles (UCLA))

Scientific Overview:

One of the challenges for machine learning, AI, and computational neuroscience is the problem of learning representations of the perceptual world. This summer school reviewed recent developments in feature learning and learning representations, with a particular emphasis on "deep learning" methods, which can learn multi-layer hierarchies of representations.

Topics included unsupervised learning methods such as stacked restricted Boltzmann machines, sparse coding, denoising auto-encoders, and methods for learning over-complete representations; supervised methods for deep architectures, metric learning criteria for vector-space embeddings; deep convolutional architectures and their applications to images, video, audio, and text; compositional hierarchies and latent-variable models.

Mathematical issues will be addressed, particularly how to characterize the low-dimensional structure of natural data in high-dimensional spaces; training density models with intractable partition functions; the geometry of non-convex and ill-conditioned loss functions for deep learning; efficient optimization methods for inference and deep learning; the representational efficiency of deep architectures, and the advantages of high-dimensional and over-complete representations.

The Canadian Institute for Advanced Research (CIFAR) cosponsored the program by supporting 10 Canadian students.

WORKSHOP: Quantum Communication: Secure Information Transmission in the Maritime Environment
August 28 – 30, 2012

Organizing Committee:

Thomas Chapuran (Applied Communication Sciences)
Richard Hughes (LANL)
Renato Renner (ETH, Zurich)
Jeffrey Shapiro (MIT)
John Smolin (IBM)

Scientific Overview:

IPAM hosted this meeting on behalf of the Office of Naval Research. The workshop discussed the current capabilities and future prospects for quantum communication, motivated by the application of optical communication in a maritime environment. The workshop brought together an invited set of leading researchers from academia, industry and government. The schedule consisted of talks and panel discussions, with ample time for individual interactions.

OUTREACH AND OTHER ACTIVITIES, 2011-2012

Math Institutes Open House, January 4, 2012. IPAM was one of 14 math institutes sponsoring this reception at the 2012 Joint Mathematics Meetings in Boston.

"UCLA Day" Information Fair; May 5, 2012. IPAM Assistant Director Stacey Beggs and IPAM participant Susana Serna (Plasma Physics) spoke to alumni about IPAM and distributed publicity materials.

Many RIPS 2011 (both LA and Hong Kong) students presented posters of their RIPS research at the Joint Mathematics Meetings, the national meeting of SACNAS, and the Nebraska Conference for Undergraduate Women in Mathematics with IPAM support for their travel and/or lodging. Additionally, a student on the Aerospace Corporation team presented their research at the IEEE Aerospace Conference in March 2012, with support from both IPAM and The Aerospace Corporation.

IPAM supported five women (former participants of IPAM programs) to attend the AWM anniversary conference, held at ICERM on September 17-18, 2011.

Finally, IPAM continues to support AWM MentorNet, which offers an e-mentoring program for undergraduates and graduate students, a résumé database for students, and other resources.

K. PROGRAM CONSULTANT LIST

IPAM consulted a variety of scholars and practitioners in the scientific planning of each program. The list is organized by program, in chronological order, starting with the Genomics long program (GEN2011). Upcoming programs for which planning had begun by August 2012 are also included. See also *Section O: Committee Membership* for members of our Science Advisory Board and Board of Trustees.

GEN2011

Eleazar Eskin, University of California, Los Angeles (UCLA), Computer Science

Phil Green, University of Washington

Stanley Nelson, University of California, Los Angeles (UCLA), Human Genetics

Lior Pachter, University of California, Berkeley (UC Berkeley), Mathematics

Matteo Pellegrini, University of California, Los Angeles (UCLA), Molecular, Cell, and Developmental Biology

Sebastien Roch, University of Wisconsin-Madison, Mathematics

Eric Schadt, Pacific Biosciences

Elizabeth Thompson, University of Washington

Wing Wong, Stanford University, Statistics

GENTUT

Eleazar Eskin, University of California, Los Angeles (UCLA), Computer Science

Matteo Pellegrini, University of California, Los Angeles (UCLA), Molecular, Cell, and Developmental Biology

Sebastien Roch, University of Wisconsin-Madison, Mathematics

GENWS1

Phil Green, University of Washington

Matteo Pellegrini, University of California, Los Angeles (UCLA), Molecular, Cell, and Developmental Biology

Aviv Regev, Broad Institute

Eric Schadt, Pacific Biosciences

Jay Shendure, University of Washington

Yun Song, University of California, Berkeley (UC Berkeley)

DOD2011

Russel Caflisch, Institute for Pure and Applied Mathematics, IPAM Director

Robert Kosut, SC Solutions, Inc.

Stanley Osher, University of California, Los Angeles (UCLA)

GENWS2

Sandrine Dudoit, University of California, Berkeley (UC Berkeley), Biostatistics and Statistics

Lior Pachter, University of California, Berkeley (UC Berkeley), Mathematics

Matteo Pellegrini, University of California, Los Angeles (UCLA), Molecular, Cell, and Developmental Biology

Barbara Wold, California Institute of Technology, Biology Division

Wing Wong, Stanford University, Statistics

MMW2011

Ricardo Cortez, Tulane University

Suzanne Lenhart, University of Tennessee

Christian Ratsch, Institute for Pure and Applied Mathematics, IPAM Associate Director

Ivelisse Rubio, University of Puerto Rico, Computer Science

GENMINI

Stanley Nelson, University of California, Los Angeles (UCLA), Human Genetics

Ben Raphael, Brown University

Jasmine Zhou, University of Southern California (USC)

GENWS3

Cedric Chauve, Simon Fraser University

Scott Edwards, Harvard University

Daniel Huson, Eberhard-Karls-Universität Tübingen

James Lake, University of California, Los Angeles (UCLA), MBI, MCDB, Human Genetics

Sebastien Roch, University of Wisconsin-Madison, Mathematics

GENWS4

Carlos Bustamante, Stanford University

Eleazar Eskin, University of California, Los Angeles (UCLA), Computer Science

Steve Evans, University of California, Berkeley (UC Berkeley), Statistics

Phil Green, University of Washington

Elizabeth Thompson, University of Washington

TRA2011

Alexandre Bayen, University of California, Berkeley (UC Berkeley)

Helene Frankowska, Centre National de la Recherche Scientifique (CNRS)

Jean-Patrick Lebacque, IFSTTAR/GRETTIA

Benedetto Piccoli, Rutgers University-Camden

Michael Zhang, University of California, Davis (UC Davis)

MS2012

Juan Bello, New York University

Samy Bengio, Google Inc.

Ronald Coifman, Yale University

Kristen Grauman, University of Texas at Austin

Yosi Keller, Bar-Ilan University, Electrical Engineering

Yann LeCun, New York University, Canadian Institute for Advanced Research

Cordelia Schmid, INRIA

GM2012

David Gamarnik, Massachusetts Institute of Technology, Sloan School of Management

Andrea Montanari, Stanford University

Devavrat Shah, Massachusetts Institute of Technology

Prasad Tetali, Georgia Institute of Technology

Rüdiger Urbanke, EPFL (Ecole Polytechnique Fédérale de Lausanne)

Martin Wainwright, University of California, Berkeley (UC Berkeley)

SAR2012

Brett Borden, Naval Postgraduate School

Margaret Cheney, Rensselaer Polytechnic Institute, Mathematical Sciences

Scott Hensley, Jet Propulsion Laboratory

Eric Mokole, United States Naval Research Laboratory

George Papanicolaou, Stanford University, Mathematics

Edmund Zelnio, Air Force Research Laboratory

PDE2012

Luis Caffarelli, University of Texas at Austin

Rustum Choksi, McGill University

Luis Silvestre, University of Chicago

Dejan Slepcev, Carnegie-Mellon University

Luminita Vese, University of California, Los Angeles (UCLA), Mathematics

PL2012

Christina Back, General Atomics

Andrew Christlieb, Michigan State University, Mathematics

Jill Dahlburg, United States Naval Research Laboratory

Michael Desjarlais, Sandia National Laboratories

Frank Graziani, Lawrence Livermore National Laboratory

Leslie Greengard, New York University

David Levermore, University of Maryland, Department of Mathematics

Warren Mori, University of California, Los Angeles (UCLA), Physics/Engineering

Michael Murillo, Los Alamos National Laboratory

PLTUT

Andrew Christlieb, Michigan State University, Mathematics

Jill Dahlburg, United States Naval Research Laboratory

Michael Desjarlais, Sandia National Laboratories

Frank Graziani, Lawrence Livermore National Laboratory

Leslie Greengard, New York University

Warren Mori, University of California, Los Angeles (UCLA), Physics/Engineering

Michael Murillo, Los Alamos National Laboratory

PLWS1

Christina Back, General Atomics

John Castor, Lawrence Livermore National Laboratory, Physics

Frank Graziani, Lawrence Livermore National Laboratory

Denise Hinkel, Lawrence Livermore National Laboratory

David Levermore, University of Maryland, Department of Mathematics

Vyacheslav Lukin, United States Naval Research Laboratory

Igor Sokolov, University of Michigan, AOSS

PLWS2

Jeff Candy, General Atomics

Vincent Chan, General Atomics

Jill Dahlburg, United States Naval Research Laboratory

William Dorland, University of Maryland, Physics

James Drake, University of Maryland, Physics

Leslie Greengard, New York University

Vyacheslav Lukin, United States Naval Research Laboratory

PLWS3

Andrea Bertozzi, University of California, Los Angeles (UCLA), Mathematics

Andrew Christlieb, Michigan State University, Mathematics

Phil Colella, Lawrence Berkeley Laboratory

William Dorland, University of Maryland, Physics

Leslie Greengard, New York University

David Levermore, University of Maryland, Department of Mathematics

Warren Mori, University of California, Los Angeles (UCLA), Physics/Engineering

James Rossmanith, University of Wisconsin-Madison, Department of Mathematics

PLMINI

Evan Johnson, University of Wisconsin-Madison, Mathematics

Andreas Markmann, Yale University, Chemistry

Noah Reddell, University of Washington, Aeronautics and Astronautics

PLWS4

Michael Desjarlais, Sandia National Laboratories

Stephanie Hansen, Sandia National Laboratories

Michael Murillo, Los Alamos National Laboratory

Ronald Redmer, Universität Rostock

Samuel Trickey, University of Florida

GSS2012

Yoshua Bengio, University of Montreal, Canadian Institute for Advanced Research

Geoffrey Hinton, University of Toronto, Canadian Institute for Advanced Research

Yann LeCun, New York University, Canadian Institute for Advanced Research

Andrew Ng, Stanford University, Canadian Institute for Advanced Research

Stanley Osher, University of California, Los Angeles (UCLA)

QUANT2012

Thomas Chapuran, Applied Communication Sciences

Richard Hughes, Los Alamos National Laboratory

John Smolin, IBM Systems and Technology Group

MD2012

Vasily V. Bulatov, Lawrence Livermore National Laboratory

Jiun-Shyan Chen, University of California, Los Angeles (UCLA), Civil & Environmental Eng

Kristen Fichthorn, Pennsylvania State University

Nasr Ghoniem, University of California, Los Angeles (UCLA), Mechanical & Aerospace Engr.

Mitchell Luskin, University of Minnesota, Twin Cities

Michael Ortiz, California Institute of Technology, Aeronautics and Applied Mechanics

Tim Schulze, University of Tennessee, Math

Vivek Shenoy, Brown University

Axel Voigt, Technishche Universtitat Dresden

MDTUT

Jiun-Shyan Chen, University of California, Los Angeles (UCLA), Civil & Environmental Eng

Mitchell Luskin, University of Minnesota, Twin Cities

Tim Schulze, University of Tennessee, Math

Axel Voigt, Technishche Universtitat Dresden

MDWS1

Eric Cances, École Nationale des Ponts-et-Chaussées, Applied Mathematics

Kristen Fichthorn, Pennsylvania State University

Graeme Henkelman, University of Texas at Austin, Department of Chemistry

Nick Kioussis, California State University, Northridge (CSU Northridge)

Axel Voigt, Technishche Universtitat Dresden

MDWS2

Vasily V. Bulatov, Lawrence Livermore National Laboratory

Wei Cai, Stanford University

Marisol Koslowski, Purdue University

Talat Rahman, University of Central Florida

Tim Schulze, University of Tennessee, Math

Ellad Tadmor, University of Minnesota, Twin Cities

Axel Voigt, Technishche Universtitat Dresden

MDWS3

Nasr Ghoniem, University of California, Los Angeles (UCLA), Mechanical & Aerospace Engr.

David Kinderlehrer, Carnegie-Mellon University

John Lowengrub, University of California, Irvine (UCI), Mathematics

Nele Moelans, Katholieke Universiteit Leuven

Vivek Shenoy, Brown University

MDWS4

Jiun-Shyan Chen, University of California, Los Angeles (UCLA), Civil & Environmental Eng

Jacob Fish, Columbia University

Mitchell Luskin, University of Minnesota, Twin Cities

Michael Ortiz, California Institute of Technology, Aeronautics and Applied Mechanics

Axel Voigt, Technishche Universtitat Dresden

SI2013

Maryam Fazel, University of Washington, Electrical Engineering

Mehran Mesbahi, University of Washington, Aeronautics and Astronautics

Nathan Srebro, University of Chicago, Computer Science, Toyota Technological Institute

Lieven Vandenberghe, University of California, Los Angeles (UCLA), EE

ADA2013

Laura Balzano, University of Michigan, Electrical and Computer Engineering

Ingrid Daubechies, Duke University, Applied Harmonic Analysis

Tom Hou, California Institute of Technology, Applied and Computational Mathematics

Norden Huang, National Central University

Haomin Zhou, Georgia Institute of Technology, School of Mathematics

CRM2013

Xavier Bresson, City University of Hong Kong

Antonin Chambolle, École Polytechnique

Tony Chan, Hong Kong University of Science and Technology

Daniel Cremers, Technische Universtitat München

Stanley Osher, University of California, Los Angeles (UCLA)

Thomas Pock, Technische Universität Graz, Institute for Computer Graphics and Vision

Gabriele Steidl, Universität Kaiserslautern

MN2013

Tülay Adali, University of Maryland Baltimore County

Mark Cohen, University of California, Los Angeles (UCLA)

Klaus-Robert Müller, Technische Universität Berlin

IAG2013

Mario Bonk, University of California, Los Angeles (UCLA), Mathematics

John Garnett, University of California, Los Angeles (UCLA), Mathematics

Ursula Hamenstädt, University of Bonn, Mathematics Institute

Pekka Koskela, University of Jyväskylä

Eero Saksman, University of Helsinki

IAGTUT

Mario Bonk, University of California, Los Angeles (UCLA), Mathematics

John Garnett, University of California, Los Angeles (UCLA), Mathematics

Ursula Hamenstädt, University of Bonn, Mathematics Institute

Pekka Koskela, University of Jyväskylä

Eero Saksman, University of Helsinki

IAGWS1

Luigi Ambrosio, Scuola Normale Superiore

Pekka Koskela, University of Jyväskylä

Nages Shanmugalingam, University of Cincinnati

Karl Sturm, Universität Bonn

IAGWS2

Giovanni Forni, University of Maryland

Ursula Hamenstädt, University of Bonn, Mathematics Institute

Misha Lyubich, SUNY Stony Brook

Vlad Markovic, California Institute of Technology

IAGWS3

Mario Bonk, University of California, Los Angeles (UCLA), Mathematics

Marianna Csörnyei, University of Chicago

Bruce Kleiner, New York University

Jeremy Tyson, University of Illinois at Urbana-Champaign

Stefan Wenger, Université de Fribourg

IAGWS4

John Garnett, University of California, Los Angeles (UCLA), Mathematics

Tadeusz Iwaniec, Syracuse University

Steffen Rohde, University of Washington, Mathematics

Eero Saksman, University of Helsinki

Tatiana Toro, University of Washington, Mathematics

GSS2013

Don Geman, Johns Hopkins University, Applied Mathematics and Statistics

Fei Fei Li, Stanford University

Deva Ramanan, University of California, Irvine (UCI)

Stefano Soatto, University of California, Los Angeles (UCLA), Computer Science

Zhuowen Tu, University of California, Los Angeles (UCLA), School of Medicine

Alan Yuille, University of California, Los Angeles (UCLA)

MSE2013

Martin Bazant, Massachusetts Institute of Technology

Giulia Galli, University of California, Davis (UC Davis), PAT

Graeme Henkelman, University of Texas at Austin, Department of Chemistry

Keith Promislow, Michigan State University, Mathematics

Matthias Scheffler, Fritz-Haber-Institut der Max-Planck-Gesellschaft, Theory Department

CCG2014

Jordan Ellenberg, University of Wisconsin-Madison

Nets Katz, California Institute of Technology

Micha Sharir, Tel Aviv University

Jozsef Solymosi, University of British Columbia, Mathematics

L. PUBLICATIONS LIST

The following publications are the participants' responses to "Please list up to three publications of the past year (including preprints and technical papers) that were a result of or influenced by your participation at the IPAM program" which was part of a survey conducted in the spring of 2013. For this 2011-2012 annual report, we surveyed participants of the 2011 summer programs and the two long programs in 2011-2012, Genomics and Plasma Physics. Note that some papers with multiple authors are listed twice (reported by two different participants). As these publications are self-reported, the formatting of the citations is inconsistent.

Graduate Summer School: Probabilistic Models of Cognition (Summer 2011)

Abbott, Joshua, Psychology, University of California, Berkeley (UC Berkeley)

J.T. Abbott, J.L. Austerweil, and T.L. Griffiths. Human memory search as a random walk in a semantic network. Advances in Neural Information Processing Systems 25, 2012.

J.T. Abbott, J.L. Austerweil, and T.L. Griffiths. Constructing a hypothesis space from the Web for large-scale Bayesian word learning. Proceedings of the 34th Annual Conference of the Cognitive Science Society, 2012.

J.T. Abbott, T. Regier, and T.L. Griffiths. Predicting focal colors with a rational model of representativeness. Proceedings of the 34th Annual Conference of the Cognitive Science Society, 2012.

Jern, Alan, Psychology, Carnegie-Mellon University

A probabilistic account of exemplar and category generation. Cognitive Psychology. 2013.

A decision network account of reasoning about other people's choices. Submitted, 2013.

Levy, Roger, University of California, San Diego (UCSD)

Nathaniel J. Smith and Roger Levy. The effect of word predictability on reading time is logarithmic. Cognition, 2013. In press.

Leon Bergen, Noah D. Goodman, and Roger Levy. 2012. That's what she (could have) said: How alternative utterances affect language use. Proceedings of the 34th Annual Meeting of the Cognitive Science Conference.

Klinton Bicknell and Roger Levy. 2012. Word predictability and frequency effects in a rational model of reading Proceedings of the 34th Annual Meeting of the Cognitive Science Conference.

Lieder, Falk, Physics, ETH Zürich

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M. INDUSTRIAL AND GOVERNMENTAL INVOLVEMENT

We have significant involvement of industry and government labs in our summer program, Research in Industrial Projects for Students (RIPS). See the program description for RIPS-LA (Section J, page 35) for a complete list of sponsors.

This was our second year of RIPS-Hong Kong. Our partner, Hong Kong University of Science and Technology, recruited the sponsors. They included Beijing Genomics Institute (BGI), Huawei (telecommunications), the Hong Kong Observatory (weather forecasting) and MetLife. See the program description (Section J, page 34) for more information.

IPAM received a grant from DOD to conduct a workshop entitled "Future Directions in Mathematics." The workshop was held at IPAM in October 2011. See the program description (Section J, page 15) for more information. Similarly, the Quantum Communications workshop was held on behalf of the Office of Naval Research (Section J, page 37).

Out of 2,355 participants total, about 200 came from government agencies, military, and national labs, and about 125 came from corporations. Researchers from the aerospace industry as well as JPL, Air Force, and Navy attended the Synthetic Aperture Radar workshop. The Plasma Physics program saw participation from General Atomics and several national labs. The summer school on Machine Learning was attended by researchers at Adobe, Google, and Bank of America. The Genomics program attracted researchers at genomics research institutes. Siemens, Qualcomm, HRL, Sensys, and Caltrans sent their researchers to the Traffic Modeling workshop. A number of

companies including Google, Micrsoft, and Yahoo were interested in the Multimedia Search workshop. The national labs and military were represented at many of our workshops and reunion conferences.

Our Science Advisory Board includes two members from Microsoft Research. Our Board of Trustees includes Al Hales (CCR West), Jeff Saltzman (AstraZeneca), Pieter Swart (Los Alamos National Lab), and David Balaban (Amgen), and we recently recruited Alan Lee from AMD. Alan Lee and David Balaban have been helping us improve our connections with industry, and devise and market corporate sponsorship opportunities.

Ten individuals representing the military and national labs served on organizing committees of several workshops and the spring long program on Plasma Physics. Seven program organizers came from industry, including IBM, SC Solutions, Google, and General Atomics.

Here are a few comments from representatives of industry and government labs who have attended IPAM programs.

"In part as a result of the issues discussed at the summer school, I proposed a topic for basic research on structured machine learning for scene understanding to ONR senior management. The topic was approved with a budget of $1.4M/year for four years. The BAA was issued, proposals are already reviewed and selected. Projects will start July 2013."
- Behzad Kamgar-Parsi, Office of Naval Research (writing about GSS2011)

"IPAM is a forward looking math institute and when it comes to workshops that push the frontiers, I come to IPAM for help." - Wen Masters, ONR

"IPAM has had a drastic effect on my research, as well as on my career. Recently, I was awarded a Swiss National Science Foundation professorship thanks to a proposal that was based on research partially carried out at IPAM. Many professional contacts and relationships have been established because of my involvement with IPAM. I also organized and chaired the CCS long program. This effort greatly advanced the field, and spurred many new collaborations. The assistance of the IPAM team before and during the program was outstanding, and crucially contributed towards its success." - Anatole Von Lilienfeld, Argonne National Laboratory

"IPAM plays a critical role in providing close coupling between fundamental science and applied mathematics and engineering applications." - John Luginsland (AFOSR)

N. EXTERNAL SUPPORT

In addition to the funding listed in Table N below, IPAM receives substantial in-kind financial support from UCLA. The Director's entire salary and administrative stipend are paid directly by UCLA. The Director of Special Projects is released from two courses at the cost of replacing him by a junior person. IPAM is not charged for the use of its building or for custodial care. The value of these items is considerable. Additionally, senior long-term participants from other

universities are usually funded on a teaching replacement-buyout basis, by which they are released from teaching for the cost of hiring a junior person as a replacement.

Table N: Other Funding Support, 2011-2012	
Federal Grants	**Amount**
NSF-IRES: RIPS-Hong Kong	$150,000
US Army Conference Grant	15,000
Sub-total	165,000
University Funding Support	
Dean Physical Sciences	129,883
Vice Chancellor for Research's Support	130,027
Sub-total	259,910
Industrial Affiliates and Other Support	
Aerospace	15,000
Arete	15,000
HRL Laboratories	15,000
IBM	16,500
Intel Corporation	16,000
Microsoft	15,000
Standard & Poors	15,000
Symantec	15,000
Sub-total	122,500
Others	
The Canadian Institute for Advanced Research	23,800
MSRI – SACNAS Reimbursement	37,875
Registration Fees-Programs	25,255
Green Family Lectureship Foundation Interest	5,865
Sub-total	92,795
TOTAL	**$640,205**

O. COMMITTEE MEMBERSHIP

IPAM's committees include the Board of Trustees and Science Advisory Board. The members of each during the 2011-2012 academic year are listed below. (Some of them have since finished their term.)

Science Advisory Board

Full Name	Discipline/Expertise	Institution
Caflisch, Russel	Applied Math	UCLA-IPAM
Cohn, Henry	Math/Cryptography	Microsoft Research
Duan, Jinqiao	Mathematics	UCLA-IPAM
Green, Mark	Mathematics	UCLA
Hastings, Matthew	Physics	Microsoft Research
Jones, Peter Wilcox	Mathematics	Yale University
LeCun, Yann	Computer Science	New York University
Levermore, David	Applied Math	University of Maryland
Naor, Assaf	Mathematics	New York University
Osher, Stanley	Applied Math	UCLA-IPAM
Ratsch, Christian	Physics	UCLA-IPAM
Schwartz, Richard	Mathematics	Brown University
Tao, Terence	Mathematics	UCLA
Thompson, Elizabeth	Biostatistics	University of Washington
Tomlin, Claire	Electrical Engineering	UC Berkeley
Wilkinson, Amie	Mathematics	Univ. of Chicago
Wright, Stephen	Computer Science	University of Wisconsin - Madison
Yu, Bin	Statistics	UC Berkeley

Board of Trustees

Name		Department or Title	Institution
Russel	Caflisch	IPAM	UCLA
Tony	Chan	President	HKUST
Jinqiao	Duan	IPAM	UCLA
Mark	Green	Mathematics	UCLA
Alfred	Hales	Director	CCR West
Bryna	Kra	Mathematics	Northwestern University
Alan	Lee	Corporate Vice President, R&D	AMD Research
William	Massey	Mathematics	Princeton
Juan	Meza	High Performance Computing Research	UC Merced
Stanley	Osher	IPAM	UCLA
Christian	Ratsch	IPAM	UCLA
Jeffrey	Saltzman	Senior Director, R&D	AstraZeneca
Ronald	Stern	Mathematics	UC Irvine
Pieter	Swart	Mathematical Modeling and Analysis (T-7)	Los Alamos National Lab
Tatiana	Toro	Mathematics	Univ. of Washington

Note: Sallie Keller (Dean of Engineering, University of Waterloo) joined the Board in fall 2012.

P. CONTINUING IMPACT OF PAST IPAM PROGRAMS

We wanted to share with you a few comments and anecdotes from participants of programs prior to the past academic year that testify to the continuing impact their participation had made on their careers and research.

IPAM's long program on optimization provided an enormous boost to the area. The guest lists included many names of people outside of traditional "core" optimization, in perfect accord with the truly interdisciplinary nature of modern optimization research. The workshops and visitor program led to many connections being made and solidified. I personally benefited by talking to younger people such as Joel Tropp, Jared Tanner, Wotao Yin, and Shiqian Ma, and by discussions on new topics with Stan Osher, Don Goldfarb, and Yurii Nesterov - among many others. The visitor program attracted a number of stars, such as Pablo Parrilo. The meeting rates high on the list of significant events in continuous optimization during the past decade. It included some remarkable talks that introduced new ideas to new listeners.
-Stephen Wright, Wisconsin (Optimization long program, 2010)

"For me, RIPS was a life-changing experience [that helped] me to succeed in my later research endeavors. After graduating from Ohio University with a BS in Mathematics (2012), I was awarded a one-year research fellowship at Stanford Law School. My research fellowship was recently extended for a second year, and in the fall I will begin Stanford University's MS program in Management Science & Engineering."
– Kristen Altenburger, Ohio State and Stanford (RIPS-Hong Kong 2011)

"I've been focusing recently on both large-scale categorization problems and approximation algorithms for Bayesian inference. Both endeavors have grown out of IPAM and collaborations with students and faculty that participated in IPAM (some participating graduate students in particular - Falk Leider, Chris Holdgraf, Alex Carstensen, and Kevin Smith, and some faculty - Ed Vul, Charles Kemp, Noah Goodman). Berkeley and Stanford have also set up a bi-semester joint meeting with the respective computational cognitive science labs from each campus - named 'Bay Bayes'."
- Joshua Abbott, Psychology, University of California, Berkeley (GSS2011)

"I got to know the work of Dr. Song-Chun Zhu's group in IPAM GSS 2011 and have joined his group in 2012 as a postdoc to work on topics of mutual interest."
- Kewei Tu, Computer Science, Iowa State University (GSS2011)

"I was a freelance science journalist who participated as an auditor. The background and credibility the course gave me was key to my obtaining a job as a staff science writer at The Salk Institute, where I help the general public to understand the significance of NSF (and NIH) sponsored research. I would highly recommend the course should be repeated and an invitation extended to a science journalist to audit every year it is presented."
- Karen Heyman, Science/AAAS (GSS2011)

“Attending the GSS probabilistic models of cognition has been an inspiring and eye-opening experience, because it showed me that higher cognition—the essence of human intelligence that has always fascinated me—is amenable to the rigorous mathematical modeling that I consider essential for understanding cognition. This made me switch my research direction from computational neuroscience to computational cognitive science. This summer school may be the key reason, or at least one of the key reasons, why I will do my PhD in computational cognitive science with Tom Griffiths or Noah Goodman.”
- Falk Lieder, Physics, ETH Zürich (GSS2011)

“All in all, the IPAM summer school has been instrumental in the development of our current research tract, and it literally opened my eyes to the world of Bayesian statistics and analysis.”
- Steven Thurman, Cognitive Science, University of California, Irvine (GSS2011)

“Positive engaging workshop environment in a small, familiar setting. Unique and rare experience for a minority faculty member (African-American). Recommended to other faculty members (Ray O'Neal, Roselyn Williams) who then participated in IPAM events. Was able to recommend and get into the RIPS undergraduate summer research program one undergraduate physics/math major in summer 2012 (Sasha Matthews).”
- Mark Jack (Physics, Florida A&M), writing about Metamaterials workshop, 2010

APPENDIX 1: Meeting of Institute Directors, Minutes and Report

Minutes and Report
Mathematics Institute Directors Meeting
ICERM
May 11-12, 2012

In Attendance May 11, 2012:

Hélène Barcelo, MSRI
Jeff Brock, ICERM
Robert Bryant, MSRI
Russell Caflisch, IPAM
Brian Conrey, AIM
David Levermore (chair), U of MD
Robert MacPherson, IAS
David Farmer, AIM
Peter Goddard, IAS
Marty Golubitsky, MBI
Jill Pipher, ICERM
Richard Smith, SAMSI
Fadil Santosa, IMA

1. Welcome

David Levermore prefaced the meeting with information about upcoming NRC reports. David informed the group he will be stepping down as chair of MIDs as of July 1, 2012. Don Saari to chair for next three years.

2. Discussion/Approval of May 2011 Minutes

A request to correct the spelling of Hélène Barcelo's name on page 25 of the May 2011 minutes was made. A vote was taken to approve the minutes with this change. All were in favor, none opposed. There was no further discussion.

3. Proposals to support an African Mathematics center:

Hélène sought consensus on whether or not the MIDs group would support an Institute of Mathematics in Africa. MSRI had recently received several proposals after the Simon's Foundation set-up a competitive proposal process.

Discussion occurred about where math is most active in Africa, primarily South Africa and in some Northern African summer schools.

The following challenges were outlined:

- Africa's focus seems to be "education" as opposed to "research";
- challenging to get funding in support of just teaching – requesting funds to support postdoctoral fellows to travel to U.S. or Canada would likely be more successful;
- finding appropriate participants to tap/invite to programs;

- casting the net broadly enough; there are no pan-African groups – research occurs mostly country by country;
- securing funding to bring African researchers to the U.S. (there aren't that many African funding agencies besides AIMS);
- avoiding the duplication of efforts in trying to collect data on Africa mathematicians and researchers;
- differentiating which applications to the NSF math institute programs are legitimate and which are spam. There are two websites that can help identify spammers:
  http://scamcrime-p-t.blogspot.com/
  http://www.anti-scam-forum.net/openThread_1232762250.htm

Suggestions/Resources:

- Create a database of researchers from Africa with MR numbers – similar to the one the Mathematical Congress of the Americas (MCA) 2013 group has created specifically listing South and Central American mathematicians. Brian Conrey volunteered AIM to create an African researcher database.
- Get suggestions from Phillip Griffiths who helped create IAS's Science Initiative Group (SIG) has worked with the World Bank and other partners to strengthen science in developing nations, including sub-Saharan Africa and Vietnam.
- Reference existing website http://www.math.buffalo.edu/mad/.
- Make a proposal to the NSF Science Across Virtual Institutes (SAVI) program.

4. Timing of the Simons Foundation sabbatical and fellowship applications and the Foundation's policy of pre-approval:

The Simons Foundation issues annual sabbatical fellowships. They require letters of commitment that their fellows will be accepted into an institute's program before most institute selection committee meetings (for example, AIM and IAS).

Discussion occurred regarding options such as a rolling admissions and/or institute selection committees meeting twice a year. The concern is that if Simons Foundation fellowship applicants don't get a commitment from an institute, they won't get an award.

Robert Bryant volunteered to draft a letter to the Simons Foundation requesting a reconsideration of their sabbatical fellowship deadline date. He will share it with the MIDs group for feedback before forwarding to the Simons Foundation.

5. Discussion of February PCSAT report:

Even though the PCSAT report doesn't affect the Math Institutes directly, it was felt it could effect future NSF-DMS decisions and negatively influence the number of future mathematics graduates. Since the leaders of MIDs have a vision of education and training at all levels they should have an official reaction to it.

Concerns about the PCSAT report:

a) Lack of representation in mathematics on this year's committee,
b) Lack of appreciation/understanding of the educational value of being taught by people with proficiency (engineering faculty don't want to teach the math);
c) Lack of appreciation for skill-based education.

Professional mathematics societies like SIAM, MAA and AWM have already drafted and/or sent a response to the report. It was suggested that the MIDs group compare notes with these and other organizations for consistency of message.

Jill Pipher was volunteered to draft a letter from the MIDs group.

6. Plans for JMM Institute reception 2013:

IPAM, AIM and MSRI are closest to the 2013 meeting site in San Diego. Russell C. indicated he is willing to check out the site. IPAM and AIM directors are organizing the event. There has already been a telecon with Georgia.

Plans so far:

- Reception will be similar to the launch of the MPE 2013 program
- Invited lecturer will be nominated by MPE group to help increase interest and attendance
- Perhaps pay to have special flier added to registration materials
- Each institute would have exhibit tables as usual, featuring MPE 2013
- Each institute to contribute 6 slides (if room is conducive to big-screen slide show)
- Perhaps a ribbon cutting and toast (photo op for launch of MPE 2013)

7. Future AWM Research Conferences:

Jill talked about AWM's first stand-alone research conference which was held to celebrate the organization's 40th anniversary. It was funded largely by NSF, with some funding from the DOE for grad students.

AWM will put together a proposal in hopes of continuing to fund conferences every couple of years at half the scale of the anniversary event (approximately 125 people). AWM wanted to know if the NSF Math Institutes will support these conferences by providing event support:

The MIDs group expressed interest in providing on-the-ground support for AWM conferences. Jill will check to see if a letter of support will be helpful for AWM's grant request.

8. IPAM approached by Lee Jamison (NSF) and DTRA:

A million dollars in awards is available to find the best algorithm for specific proposed problem. The group wants the help of math institutes to advertise the competition to the community. Competition to start in September. They are looking for ideas, since there is not enough time to have a workshop.

It was suggested that someone give a talk on the project and videotape it, or provide a webinar. Once complete, it could be shared with the institutes for broader distribution.

9. Issues related to the STPI proposed evaluation of the institute portfolio:

It was agreed that MIDs should propose specific programs to STPI for long-range studies.

In attendance on Saturday, May 12, 2012:

Hélène Barcelo, MSRI
Jeff Brock, ICERM
Robert Bryant, MSRI
Russell Caflisch, IPAM
Brian Conrey, AIM
David Levermore (chair), U of MD
Robert MacPherson, IAS
David Farmer, AIM
Peter Goddard, IAS
Marty Golubitsky, MBI
Jill Pipher, ICERM
Richard Smith, SAMSI
Fadil Santosa, IMA
Sastry Pantula, Division Director
Henry Warchall, Deputy Division Director
Mary Ann Horn, Program Officer
Joanna Kania-Bartoszynska, Program Officer
Tara Smith, Program Officer
Christopher Stark, Program Officer

1. Brief update about DMS budget and priorities:

Sastry Pantula gave an update. New at NSF this year are CREATIV, I-Corps, SAVI. Institute directors were requested to 1) help set budget drivers, 2) watch for new opportunities, 3) nominate to important committees (PCAST, MPSAC for example), and 4) continue diversity efforts and activities.

2. Update on STPI evaluation plans:

DMS solicits suggestions from the Directors about long programs for inclusion in the case studies by the Science & Technology Policy Institute (STPI). STPI wishes to study long programs that:

- include support for all of the five main categories of funded activity (long-term visitors, career development for junior investigators, collaborative activities, capacity-building activities, dissemination activities);
- were initiated no later than 2002 and completed no later than 2006; and
- have full program description available online (or easily obtainable from the Institutes).

3. Update on the institute competition:

The NSF Office of Legislative and Public Affairs (OLPA) will be contacting the Institutes receiving new awards to develop press-release material.

4. Reminder about upcoming third year visits:

Those Institutes due for third-year site visits in the upcoming year should now begin work with the cognizant DMS program director to identify feasible dates for the site visit.

5. White papers about potential budget drivers:

It would be extremely useful for DMS to receive annually from each Institute a white paper summarizing recent progress and future directions in at least one major research area reflected in the Institute's recent programming. Such white papers can be short (a few pages) and need not be polished to publication quality. Examples of white papers prepared by the community through the MPS Advisory Committee can be found, for example, in the "Briefing Book" materials at [http://www.nsf.gov/events/event_summ.jsp?cntn_id=123079&org=MPS]. Institute program organizers and participants should be interested in this opportunity to provide input to the NSF in its development of funding activities.

If community members find a particular important topical area on the threshold of major advances that would be catalyzed by increased NSF investments in the research area, and if the Institute wishes to sponsor a stand-alone workshop (or an extension of a program) for the purpose of preparing a substantial white paper on the subject, DMS will consider requests for supplemental funding to support this activity.

6. Update on how the institute directors coordinate the scientific programs at DMS supported institutes, upcoming programs, and science board meetings:

Directors updated DMS on their efforts to coordinate and cooperate: a Math Institutes Diversity Database has been constructed by several institutes and is hosted by the IMA, diversity workshops and activities coordinated through an all institutes NSF grant administered by MSRI, sharing information about potential participants in programs, coordinating future programs to avoid overlap.

7. DMS personnel participating in Institute Board meetings:

Please let DMS personnel know about upcoming meetings of your Institute's scientific advisory board. DMS may wish to send a representative, not in any attempt to furnish direction or input, but rather to gather information to help DMS understand trends in the community's interests and to help DMS formulate budget-driving initiatives.

Also in connection with Institute scientific advisory board meetings, DMS requests that each scientific advisory board prepare at least annually a summary list of interesting topics that form the basis of recent proposals for Institute programs, together with indications of the researchers DMS might contact for further information on the scientific topics.

8. Reminder about the need for highlights:

DMS requests that the Institutes furnish additional highlights for posting on the [http://mathinstitutes.org/] home page. This web site is a highly visible presence in Washington for the DMS Institutes, and the highlights banner on the home page should reflect well the vitality of the work being carried out by the Institutes.

9. Update on diversity activities:

NIMBioS is organizing the Modern Math Workshop at SACNAS in October 2012 and ICERM will host Blackwell-Tapia in November 2012.

10. Additional business:

a) The NSF Office of Legislative and Public Affairs (OLPA) will be contacting the Institutes receiving new awards to develop press-release material.

b) DMS supports with enthusiasm the suggestion to add links on the [http://mathinstitutes.org/] web page to all the various individual video archives of the Institute programs.

c) As you know, because the NSF Project Reports System does not accommodate the uploading of files of spreadsheet type, it is necessary to send the participant data spreadsheets that are required in connection with Institute project reports to DMS via e-mail. When doing so, please send the files to the cognizant NSF program director *with* a copy to <mathinstitutes@nsf.gov>. This <mathinstitutes@nsf.gov> e-mail address is intended as a "drop box" only; e-mail received there will not be actively monitored, so any messages needing a reply should instead be sent directly to DMS staff members.

d) For the future annual meetings of the Institute Directors, DMS would like the Institute Directors and other personnel attending the meetings to make their own travel reservations. These travel expenses should be paid from the Institute's budget. The Institutes receiving new awards will find an annual $4,000 plus indirect costs added to the award budget for this purpose. Each of the other five Institutes should submit to DMS, via FastLane, a (single, aggregate) request for supplemental funding of $4,000 plus indirect costs per year for each of the

remaining award years. For example, the Institute X received an award letter that said:

"The National Science Foundation hereby awards a grant of $1,000,000 to High Quality University for support of the project described in the proposal referenced above as modified by revised budget dated April 16, 2010. This project, entitled "Institute X," is under the direction of Sirius Black and Rubeus Hagrid.

This award is effective September 1, 2010 and expires August 31, 2011.

This is a continuing grant which has been approved on scientific / technical merit for approximately 5 years. Contingent on the availability of funds and the scientific progress of the project, NSF expects to continue support at approximately the following level:

-FY 2011 $1,000,000
-FY 2012 $1,000,000
-FY 2013 $1,000,000
-FY 2014 $1,000,000

This Institute should now submit a request for $12,000 (3 future meetings of the Institute Directors in the springtimes of 2013, 2014, and 2015) plus applicable indirect costs.

11. The 2013 MIDS Meeting:

The next MIDS meeting will be held at the IMA on May 3-4, 2013.