Institute for Pure and Applied Mathematics, UCLA
Annual Progress Report for 2019-2020
Award #1440415
August 10, 2020

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EXECUTIVE SUMMARY

This report covers our activities from June 10, 2019 through June 12, 2020 (which we refer to as the reporting period). This report includes the 2019 summer research programs (RIPS and GRIPS). The 2020 summer programs are underway at the time of reporting and will be included in the Final report.

IPAM held two long program in the reporting period:

- Machine Learning for Physics and the Physics of Learning (September 4 - December 8, 2019)
- High Dimensional Hamilton-Jacobi PDEs (March 9 - June 12, 2020)

IPAM held the following workshops in the reporting period:

- Modern Math Workshop 2019 (in partnership with MSRI) (October 30 - 31, 2019)
- Deep Fakery: Mathematical, Cryptographic, Social, and Legal Perspectives (November 15 - 16, 2019)
- Theory and Computation for 2D Materials (January 13 - 17, 2020)
- Emerging Opportunities for Mathematics in the Microbiome (January 23 - 24, 2020)
- Deep Learning and Medical Applications (January 27 - 31, 2020)
- Asymptotic Algebraic Combinatorics (February 3 - 7, 2020)
- Computational Psychiatry (February 18 - 21, 2020)
- Intersections between Control, Learning and Optimization (February 24 - 28, 2020)

A workshop on Mathematical Models in Understanding COVID-19 is set to take place in August 2020 which will be included in the Final report.

Furthermore, the following public lectures were organized during this period:

- Green Family Lecture Series: Can We Use Genomics to Better Understand and Treat Cancer? (January 27, 2020), Computational Genomic Approaches to the Understanding and Treatment of Cancer (January 28, 2020), by Jill Mesirov.

IPAM typically offers two reunion conferences for each IPAM long program; the first is held a year and a half after the conclusion of the long program, and the second is held one year after the first. IPAM held reunion conferences in December 2019. Due to the unprecedented crisis posed by the COVID-19 pandemic, the reunion conferences scheduled for summer 2020 were postponed.

This report includes four 2019 student research programs:

- Research in Industrial Projects (RIPS) in LA
- Research in Industrial Projects (RIPS) in Singapore
- Graduate-level RIPS in Berlin, Germany
- Graduate-level RIPS in Sendai, Japan

A. PARTICIPANT LIST

A list of all participants in IPAM programs will be provided to NSF in electronic form (Excel). The list will include participants for programs whose start dates fall between June 10, 2019 and June 12, 2020.

B. FINANCE SUPPORT LIST

A list of participants that received support from IPAM will be provided to NSF in electronic form (Excel). The list includes all funded participants of programs that occurred between September 1, 2019 and August 31, 2020.

C. INCOME AND EXPENDITURE REPORT

Grant # DMS 1440415:
This table shows appropriations and expenses for the twelve-month period June 1, 2019 through May 31, 2020 for grant #1440415.

	A	B	C	D	E	F
			A-B=C		B+D=E	A-E=F
Budget Category	Appropriation Year 5	Actual Expenses for the 12 months	Balance for the 12 months	Encumbered Expenses as of May 2020	Total & Encumbered Expenses at May 2020	Encumbered Balance as of May 2020
A. Operations Fund	$1,855,822	$1,936,217	<$80,395>	$218,998	$2,155,215	<$299,393>
B. Participant Costs	$1,789,000	$1,919,167	<$130,167>	$11,260	$1,930,427	<$141,427>
C. Indirect Costs	$865,178	$829,124	$36,054	$0	$829,124	$36,054
Totals	$4,510,000	$4,684,508	<$174,508>	$230,258	$4,914,766	<$404,766>

IPAM received an appropriation of $4,510,000 for fifth year of the grant. The NSF approved a rebudget from Participant Costs to Operations and Indirect Costs for years 3, 4, and 5. The rebudget is reflected in the appropriation.

Total expenses and encumbrances were $4,914,766 leaving a balance of $<404,766>. IPAM has a flat budget allocation of $4,510,000. We underspend the allocation in the early years of the 5-year grant and overspend the allocation in years 4 and 5. Overall, IPAM has a positive balance as of May 31, 2020.

A. The Operational Fund (salaries, benefits, equipment, and supplies) for the twelve-month period has an appropriation budget of $1,855,822 with total expenditures of $2,155,215 leaving a balance of <$299,393>. Included in the encumbered expenses is $134,766 for the subaward with California State University, Northridge for Associate Director Maria D'Orsogna.

B. Participant Support Costs include stipends, travel, housing, and subsistence for the scientists working on IPAM Programs. Participant Support Costs for the twelve-month period has an appropriation budget of $1,789,000 with total expenditures of $1,930,427 leaving a balance of <$141,427>.

C. Indirect Costs: Indirect Costs rates are based on current facilities and administrative cost rates negotiated with the Federal government and the University of California. IPAM's work is conducted at an on-campus location which is subject to 54% facilities and administrative cost rate. Indirect costs are not applied to equipment and participant support costs. Indirect Costs for the twelve-month period has an appropriation budget of $865,178 with total expenditures of $829,124 leaving a balance of $36,054.

Program Income: Registration fees for NSF-supported conferences are accounted for as program income. IPAM charges modest registration fees primarily to discourage non-serious registrations. Registration fees for workshops are $75 for faculty and government/military participants, $100 for industry participants, $50 for post-doctoral scholars and $25 for graduate students. Program income received was $16,330 for the twelve-month period and is spent entirely on participant support expenses.

D. POSTDOCTORAL PLACEMENT LIST

IPAM did not appoint postdoctoral fellows in 2019-20, so we have no data to report in this section.

E. MATH INSTITUTE DIRECTORS' MEETING REPORT

Math Institute Directors' Meeting: April 24, 2020

Friday, April 24, 2020

1. **Introductions**
   - **Brian Conrey (AIM)**
     Estelle Basor
     David Banks
   - **Akshay Venkatesh (IAS)**
   - **Brendan Hassett (ICERM)**
     Ruth Crane
     Kavita Ramanan
     Ulrica Wilson
   - **Dima Shlyakhtenko (IPAM)**
     Christian Ratsch
   - **David Eisenbud (MSRI)**
     Hélène Barcelo
   - **David Banks (SAMSI)**
     Emily Griffith
   - **Kevin Corlette (IMSI)**
   - **Juan Meza (NSF)**
     Marian Bocea
     Stefaan De Winter
     Pedro Embid-Droz
     Yuliya Gorb
     Joanna Kania-Bartoszynska
     Tie Luo
     Junping Wang

2. **Introductory remarks by Juan Meza:**

   - Juan Meza acknowledged that everyone was working under unusual circumstances due to COVID-19. He thanked all institutes for their great work adjusting their programs to accommodate the pandemic.
   - Juan encouraged everyone to keep sending programmatic updates during this time; the institute reports are useful internally.
   - The DMS's response to COVID-19 is "maximum flexibility" while trying to follow OMB guidelines. Juan acknowledged that sometimes OMB is slow and that the most up-

to-date guidance can be found on the NSF webpages. Directors were encouraged to start checking the site regularly.
- Directors should not hesitate to let the NSF team know how they can help during this time of crisis.
- All final 2020-2025 proposals are currently being reviewed by the Division of Grants and Awards. Since the funding is larger than normal, there are more cost accounting procedures. Juan will update everyone as soon as there is more to report.
- Juan welcomed Kevin Corlette.
- ACTION ITEM: Juan requested that all institute directors provide him with an estimate of people affected when programs are cancelled.

3. Approval of minutes
- Hélène Barcelo motioned to approve the April 2019 MIDS meeting minutes; Brendan Hassett seconded and there was no further discussion. All were in favor, none opposed.

4. Presentations by the Institutes on upcoming programs

- **AIM:**

  - Brian Conrey reviewed AIM's spring and summer schedules, including their plans for re-scheduling programs due to COVID-19.
  - AIM typically reserves 20 weeks for their workshops and 20 weeks for SQuaREs. They will be able to overlap SQuaREs to accommodate the workshops that get postponed.
  - Workshops: AIM has been contacting organizers two months prior to their program's start date and are having frank discussions about how to adapt workshops. Most organizers have chosen to postpone. One has canceled. Once a decision is made, AIM informs participants about the changes, and in the case of postponements, resets the clock, re-inviting everyone, including those who declined invitations before.
  - SQuaREs: same as above, but AIM reaches out to organizers on a six week clock. All spring groups have been or will be rescheduled. The summer SQuaREs are returning groups.
  - AIM always offers additional programming that benefits the community (REUF/Math Circles). This year's focus is on Braille textbooks: how to make graphics/images accessible to the blind, and get textbooks into their hands. AIM's bridge programs help prepare early career for graduate school. Joyful math is an on-line public outreach site where people can sign up and join math seminars, and add their own (not-for-profit) events to the calendar.
  - Juan asked what criteria AIM was using to determine whether to run in-person vs. on-line programs? Brian responded that AIM is following state and university restrictions. Future programs will likely be hybrids with 25-20 participants in-person and the rest virtual. A

lot of AIM organizers feel on-line won't work -- too much collaboration opportunity lost. The SQuaREs groups will be able to adapt. David's strong preference, since they have flexibility, is to reschedule when possible.

- **IAS:**

  - Akshay Venkatesh described his institute's scientific programming. Large gatherings are not the core focus of IAS. They typically host around 20 researchers who come for a year and work on topics of their choice. One or two workshops are also run during this time. Each person has their own office.
  - It will be easy for IAS to remain open during the pandemic for anyone who is able to come (based on university, state, and federal guidelines).
  - IAS is just finishing its program on Machine Learning.
  - Akshay reviewed future IAS programs.

- **ICERM:**

  - Brendan Hassett described how ICERM's spring 2020 program was off to a strong start with a very cohesive group of participants and organizers. With their help and flexibility, ICERM was able to move the remaining spring 2020 program workshops, seminars and professional development programming to a virtual platform.
  - For summer and fall programming, ICERM is currently biding time, following Brown's lead for re-opening decisions. On-campus programs have been curtailed up to July 10th and summer courses may run later in summer.
  - ICERM won't offer postponements for summer and fall programming; the schedule is too packed to allow for rescheduling. In most cases, organizers have been flexible.
  - Brendan reviewed upcoming programs. For now, participants have been asked not to purchase travel tickets in advance, and to use ICERM lodging vendors to foster easy cancelation.
  - The 2020 Summer@ICERM 8-week undergraduate research program will be offered virtually.
  - ICERM believes all programs in the foreseeable future will have a substantial virtual aspect.
  - Most ICERM postdocs for the Spring '21 semester program received NSF fellowships.
  - Juan asked if ICERM noticed any changes in attendance, going from in-person to virtual. Brendan responded that ICERM has taken attendance via Zoom screenshots, and it appears a small percentage has been lost. Also, people are more selective in which talks they attend. ICERM wants to make it easier for anyone to join its programs and interact virtually.

- **IPAM:**

  - Dima Shlyakhtenko reviewed IPAM's mission.
  - He reviewed upcoming programs and discussed the challenges of adapting to COVID-19. Dima assumes future programs will have some in-person component, based on what UCLA decides to do (hybrid with virtual).
    - IPAM has adapted their current long program to a virtual program.
    - Winter workshops will run as scheduled, likely hybrid.
    - Hoping LatinX will run in March 2021.
    - No exploratory workshops for fall – holding off due to COVID-19 uncertainty.
    - Summer School in June 2020 is postponed; IPAM will run two Summer Schools in 2021.
    - RIPS: Singapore 2020 was canceled and participants who can will be re-accommodated in LA (virtually). The 2020 LA RIPS will start on-line, with hopes the students can be brought to UCLA later, if possible.
    - G-RIPS 2020 in Japan was canceled, but students were invited to participate in the LA program virtually. Germany G-RIPS has not been canceled.

- **MSRI:**

  - David Eisenbud reviewed MSRI's core programming which consists of two major programs each semester (or one jumbo program).
  - He reviewed upcoming programs.
  - The fall 2020 organizers pressed to postpone. MSRI is working with them to offer a virtual program or a couple of shorter events.
  - MSRI is working towards a hybrid programming model (in-person and virtual) that can be repeatable.
  - Summer programs are normally very full, serving about three-hundred students from the US, abroad, and from the academic sponsors.
    - MSRI UP: starting virtual with possibility of bringing students to campus at the end, COVID-19 state and federal guidelines permitting.
    - MSRI Summer Schools: some held virtually, some postponed to summer 2021 or 2022.
    - MSRI started two new programs composed of smaller research groups:
      - for women (total of eighty) with funds to pay for daycare. Since daycare won't work during a virtual program, these programs have been pushed to summer 2021.
      - African Diaspora Joint Mathematics Workshop (ADJOINT) will be a virtual program. It had a successful pilot, and is organized similar to the UP program.
  - David Eisenbud discussed proposals being considered for future programs.

- Juan asked about MSRI UP and ADJOINT going virtual, and how the programs will work considering how important collaboration is. Hélène responded that the 6 week program may be hybrid, starting as virtual. The research leaders are thinking hard about how to engage the students. MSRI will provide every student with a tablet and software and will host a one week reunion as soon as possible if the program ends up completely virtual.
- Joanna Kania-Bartoszynska commented that many students may find it difficult to work from home.

- **SAMSI:**

  - David Farmer reviewed SAMSI's mission. They offer one semester program in the fall, and two spring programs.
    - One spring workshop has been canceled.
    - The undergraduate workshop scheduled for May was canceled.
    - Have scaled the international program back to a four-hour virtual program.
    - Virtual mentoring program to replace the summer 2020 Industrial Mathematical and Statistical Modeling workshop.
    - Blackwell-Tapia is scheduled for November; exploring a virtual option.
    - SAMSI is essentially planning for everything to go virtual for the foreseeable future.
  - Dima asked if there were any changes in the math community for proposing programs? Brendan responded that ICERM has received a lot of inquiries. People appear to still be thinking about the future.

- **Chicago-region institute (IMSI):**

  - Kevin Corlette reviewed plans for the Institute for Mathematical and Statistical Innovation. It will be a partnership between the University of Chicago, Northwestern University, and the University of Illinois. He reviewed and expanded on their mission. Their proposal was influenced by the Math Science 2025 report. Math and Statistics both appear on their marquee. The institute will be interdisciplinary with various themes, addressing important problems of society. Themes are: data and information, error and uncertainty, climate science, quantum information, medicine and healthcare, and materials science. Goals to communicate science and a focus on diversity and inclusion. Their calendar will follow the University of Chicago quarter system (similar to IPAM). Kevin reviewed a list of proposed workshop titles.
  - David Eisenbud asked about plans to manage distance between the Illinois campuses and the management of the institute between the partners. Kevin responded that each university will be represented by board membership, and they can participate virtually or travel to Chicago. There is a new bus line that runs frequently between the University of

Illinois-Springfield campus and the Chicago campus. There will be outreach activities at all sites but most scientific research will happen at the University of Chicago.

5. Presentations of collaborative activities

- **Diversity initiative:**

  - Ulrica presented a list of funded diversity events. The funding cycle is now synced up with NSF core funding schedules.
  - The fall 2020 Modern Math Workshop is in a holding pattern, waiting for SACNAS to indicate how they'll handle the impact of COVID-19. Currently no plans to attempt hosting it virtually.
  - Blackwell-Tapia is still on track, though it may be held virtually.
  - The Mathematical Sciences Institutes Diversity Initiative (MSIDI) committee recruited an advisory team from mathematicians in the URM community. Their next task is to think about what the group's summative goals should be.
  - The MSIDI is getting ready to launch its first 4-year follow-up survey; this is an opportunity to get baseline data on how well the MSIDI goals are being met in preparation for our next proposal which will be submitted in 2021. The advisory team will help formulate those goals, for example, the growth of participation in institute programs. It will be good to consider what successful mathematicians in the community would like to see as outcomes from MSIDI programming, including intermediate goals, for example, whether or not people are progressing professionally in a positive way.
  - Juan asked how the advisory team was chosen and if there were term limits. Ulrica responded that for this iteration there is a two-year commitment. The first in-person meeting will be in summer 2021 and this team will have the opportunity to contribute ideas for the next proposal. Members were selected in part from Blackwell-Tapia award winners and participants from the December 2018 and December 2019 AIM workshops (the Latinx mathematicians network I & II and the Network of mathematicians of color I & II) who expressed clear ideas about increasing URM participation in mathematics and at the institutes.

- **REUF: AIM and ICERM:**

  - Leslie Hogben explained that the idea behind the Research Experiences for Undergraduate Faculty (REUF) program is to support and encourage faculty to do research with their undergrads, and also spark their own research. More than 60% of the participants are women, 30% are from underrepresented populations, and 1/3 are from underrepresented institutions.
  - ICERM and AIM collaborate well in sharing/alternating hosting the REUF events.

- MSRI collaborations with:
  - AMS: congressional briefing
  - IAS: National Math Festival
  - Simons Foundation: Numberphile
  - CME Group (Chicago Mercantile Exchange): CME-MSRI Prize and Symposium
- These collaborations are aimed at reaching out to the broader world.
- Juan asked how MSRI selects congressional speakers for the briefings. David responded that he and Karen Saxe mostly just brainstorm names.

6. Presentations by NSF staff

- Mathematics Sciences Research Institutes part of larger institutes context: TRIPODS Institutes, NSF-Simons Math Biology Research Centers, and NSF-Simons Mathematical Foundations of Deep Learning.
  - Joanna addressed how the math institutes are a high priority for the DMS/NSF because they allow for exciting science and research to happen and reach a broad population. There is a keen interest in ensuring success.
  - The competition is in its final stages. Proposals are out of DMS and now with the Division of Grants and Awards. The CAP process can take 45-90 days.
  - All awards will be issued at the same time, allowing for a coordinated press release by the NSF.
  - Open competitions will now occur every 5 years, with everyone applying at the same time.
  - Third-year site visits have been done away with.
- Institute directors are encouraged to stay in close contact with their Program Officers (PO). POs will participate in various meetings, and should be contacted if there are any problems or good news to share.
- There is now a formal back-up list for the Program Officers.
  - The first reverse site visit went well. Positives: all non-conflicted POs were able to participate and it was felt it levelled the playing field. The team of reviewers could judge more than one project. Negatives: reviewers were under time pressure to write reports. The institute leaders were not on their own turf -- the committee does not get a full feel of the institute – including location, the functioning of the place, the atmosphere, etc.
  - Feedback from reviewers:
    - presentations that focused on review criteria and had a clear vision were most effective.
    - reviewers appreciated presentations in which the whole team participated (could see if the team had synergy).
    - appreciated advanced electronic copies of slides.

    - well-structured briefing books were most helpful.
  - Hélène asked if an institute can request an informal site-visit. Joanna responded that POs are willing to arrange them. Institutes should also expect POs to visit randomly. Institutes should always take advantage of informal visits to discuss infrastructure, ambiance, and physical space.
  - ACTION ITEM: Institute/future directors were asked to send specific feedback to Joanna regarding what worked and what didn't during the reverse site visit, and cc the NSF institute team.
- Institute/center landscape:
  - Juan described where the math institutes fit into the overall DMS portfolio; they've worked to bring institutes and centers into one portfolio.
  - DMS encourages math institutes to work with the other institutes and centers in the portfolio, and visa versa.
- Other institutes and centers in portfolio are focused on specific sets of problems. The math institutes offer more variety and convene large groups of people.
  - TRIPODS (Big Ideas – originally meant to seed larger awards) is in the middle of Phase 2 awards which will lead to 5-year grants, similar to Simons. The goal is to look at the foundations of Data Science. There are many great opportunities for TRIPODS and the institutes to overlap.
  - NSF-Simons Mathematical Foundations of Deep Learning: Grew out of MOU between NSF and the Simons Foundation. Cofunded and jointly reviewed by both agencies with a total funding commitment of $10M from each side over five years. This will support two `collaborations' with a budget of $2M a year. Proposals are coming in now.
  - National AI Research Institutes: Proposals under review now. AI is a big topic, with a lot of money pouring into it. NSF is putting together a set of programs for specific applications
  - Brendan commented that most institutes have strong independent boards. When institutes are approached by the NSF to partner with the other centers and institutes in the portfolio, they need board approval or need to be able to present a full proposal. Juan responded that institutes should shepherd NSF partnership requests when it makes sense. They should also work with their boards to think longer-term to better match the work the centers and institutes are doing. For example, biologists want math training, and math institutes seem a natural place for that training to occur.
- Policy developments: Sexual harassment/Title IX: This was an extensive topic of conversation during MIDS at JMM. In summary, circumstances occur where a speaker or organizer has allegations against them. It has been a struggle to figure out how to deal with these situations. Universities are well-equipped for these situations, but institute

visitors are “guests”. Emily Griffin commented that a participant’s home institution can take care of issues that occur at other sites.

- Juan responded that there were no changes from NSF’s (fairly new) Office of Diversity and Inclusion (ODI) on harassment guidance. ODI is working on the development of a process; this is ongoing as it is being revised as we learn more from our experiences. Juan applauded institute efforts so far and encouraged everyone to follow the rules at each particular home-institution.
  - Dima responded that incident reporting is a challenge; there is no assurance that the university would have the willingness or recourse to take action on behalf of an institution.
  - Hélène added that segments of the mathematical communities push back if the accused hasn’t been officially found to have engaged in improper conduct.
  - It seems rare to have these incidents occur on institute property. But Brendan provided a more typical anecdote: organizers recommend a speaker; a science board member indicates the speaker was removed from a previous position for sexual harassment. Organizers insist on sending the speaker an invite. Brown lawyers advise not to invite the speaker to campus without follow-up with the person’s employer to confirm the issue. But some employers have non-disclosure agreements. Universities have a very conservative approach, with premium on students, faculty and staff protection; they are not so concerned with visitors.
- Juan responded that the NSF is not an investigative body and the DMS may never hear about issues if they get reported directly to the NSF. POs can’t give any direction. But they are open to suggestions about ways they can help. The DMS ought to be able to provide some guidance. Juan will need to be run by multiple levels of approval. But they understand and want to help out.
- Joanna added that if some institutes are not hearing any Title IX complaints, they should put their antennas up higher; just because they aren’t hearing anything doesn’t mean offenses aren’t happening. She suggested institutes review how they inform participants about their Title IX policies and procedures and make sure participants are made to feel comfortable coming forward with concerns.
- Ulrica suggested the institutes might want to avoid having a known problematic participant ending up at another institute. Institutes could help protect overall institute environments. Guidance from the NSF and/or a commitment from the entire group to communicate these issues will help.

7. Discussion of pressing issues and initiatives for the next five years

- Reopening the institutes: General discussion occurred including:
  - Institutes have a special problem because they host international scientists coming from hot spots. The hot spots are moving targets (including the US).

  - There is a big difference between a short visit and a long visit. Long visits allow for quarantine time, which makes little sense for workshop visits. Campuses are struggling with same the issues
  - Having a common set of criteria for reopening from the NSF wouldn't be likely to help. Flexibility will remain important.
  - Institutes might consider sharing best practices and experiences regarding plans for reopening.
  - NSF's current stance is that each institute should decide what's best.
- Initiatives to support early career mathematicians: Brendan asked the NSF what institutes should be doing to support early career mathematicians whose job searches are impacted COVID-19. Juan agreed that helping early career researchers is important. General discussion occurred including:
  - Most universities will be thinking hard about faculty hiring for 2-3 years.
  - Institutes should prepare for a similar situation to 2008-2009, when supplemental awards for postdocs were made to institutes. These supported about 40 slots, jointly administered by the institutes, with NSF helping to coordinate.
  - Juan suspects that the federal government will push to prioritize early career and funding to put people back to work.
  - Some 2020-2021 Postdoc offers were rescinded. Hope to create life-boat appointments if institutes can accommodate more Postdocs.
- Tie Luo has spoken to the Simons Foundation and there is precedent for NSF to increase the number of Postdoc awards; 2020-2021 seems settled but next year could be a problem.
- ACTION ITEM: Keep Juan/NSF informed about anecdotal details of postdoc job issues so they can be very vocal about the need for "life-boat" funds.
- Public access repository requirements: General discussion occurred around this renewal proposal requirement. The institutes don't employ most of the people producing manuscripts, but feel obliged to "manage" the postings. However, only PIs can input papers into the repository.
  - Joanna responded that there are lots of questions about this and the issue is evolving. She responded that if publications are written by institutes then they are required to post in the repository. Otherwise, to help with NSF visibility, insist that PIs thank institutes and quote their NSF awards in their publications. Make it a requirement to acknowledge the NSF.
  - It was made clear that "collected" publications (found via survey or sent via email by past participants) don't have to be put in the repository. But the collected publications should be included in the annual reports.
  - Employed postdocs' work should be put in the repository - institutes will have to do it for them.

  - ACTION ITEM: Juan will take these concerns back to see if the repository process can be made easier, or if the guidelines can be made clearer.
- Closed captioning requirements for videos: General discussion occurred regarding whether or not automated closed captioning (CC) tools are sufficient? Is there an NSF standard? It is expensive to make sure mathematical formulas are correct via closed captioning. Juan provided the following guidance:
  - It is the law to make all content accessible. The NSF is very strict about this for NSF-hosted pages.
  - It is probably not up to NSF to enforce it on the external webpages that the institutes have created.
  - NSF could go to their general counsel for definitive rules, but… for now, institutes are encouraged to comply to the best of their abilities and funding.
  - ACTION ITEM Juan will share the NSF compliance requirements with the institutes. He will also see if there are financial resources available to help the institutes fund CC.
  - David Banks shared a website with three key CC compliance takeaways. Note that they refer to a website as part of an Institution's public accommodations. https://www.nationaldeafcenter.org/news/significance-harvard%E2%80%99ssettlement-video-accessibility
  - This issue will become more relevant with the increase of virtual programming.

8. Session with institute directors and Juan Meza

9. Next MIDS meeting: Friday, April 23, 2021 at MSRI or IPAM (ICERM as backup if necessary)

Minutes of the Math Institutes Directors' Meeting at JMM: January 15, 2020

The following institutes were represented: AIM, CIRM, DIMACS, IAS, ICERM, IPAM, SAMSI, MSRI.

1. **Approval of minutes**

The minutes of the January 2019 meeting were approved.

2. **Handling allegations of harassment**

Brendan Hassett (ICERM) brought up the question of how institutes handle allegations of misbehavior of participants. This includes instances of sexual harassment, as well as rumors of such misbehavior at other institutions or other institutes.

Several Math Institutes reported having to deal with such issues. The ways in which math institutes handle such situations vary. They involve mechanisms such as:

- Various statements of rules or conduct or community agreements, setting expectations for conduct; such rules are distributed to participants in advance or at the start of a meeting. It was noted that AMS has such language for its meetings.
- MSRI has in addition a document describing a mechanism by which allegations are handled. There is an independent 3rd party ombudsman, as well as a company that can anonymously forward to MSRI allegations of harassing behavior.
- AMS hires an outside company to gather any complaints about the meetings it runs.
- It is reported that, going forward, PIs receiving NSF conference grants must de- scribe policies and procedures that would be followed in case of such allegations. NSF does not set such policies, but leaves them to the individual PIs.

Mathematics Institutes that are housed at Universities generally abide by the policy and procedures they inherit from the host campus. These procedures are especially impactful if the alleged misbehavior involves a member of that university's community as either the accused or the injured party. In cases where the two parties are not affiliated with the parent university, university policies still apply, but enforcement and procedural mechanisms may be lacking. In the former case, privacy guarantees inherent in campus policies may limit disclosure of the substance or resolution of allegations to third parties, including other institutes.

Several instances of inappropriate behavior at various institutes were discussed, without going into details. These included:

- An Institute was made aware of past sexual harassment allegations against a person who was invited to speak at a summer school. The Institute discovered that these allegations resulted in that person being removed from their job. The Institute withdrew the speaker's invitation. The speaker responded by saying that they understood the situation.
- An Institute was made aware of allegations against a participant, which resulted, upon due investigation, in the participant's expulsion. The Institute then learned of an activity at another institute, funded through a grant supplement the Institute was holding on behalf of all of the institutes. They subsequently informed that other institute, resulting in cancellation of the person's participation in the planned activity.
- It was mentioned that the existence of a transparent mechanism for handling various allegations, in which it is clear that they are not being ignored, as well as good PR, is essential. Lack of such transparency may result in further allegations that a particular institute is not doing its due diligence, resulting in damage to the institute's reputation. In one such example, a prominent scientist accused of misconduct was slated for a highly

distinguished lecture. The inviting Institute was initially unaware of these allegations. At first, the institute hesitated to make a statement in this case, making themselves a target of accusations of ignoring harassing behavior by that scientist. The subsequent statement by the institute was "instrumentalized," making its way into a Wikipedia article, and had to be partially walked back. In short, the Institute found itself in the middle of a very unfortunate social media storm.

There was broad support for continuation of this conversation at the Spring NSF Math Institutes PI meeting.

An idea was expressed that it may be of interest to have an independent ombudsperson or similar organization that would help institutes investigate and arbitrate complaints, as well as keep track of past complaints. However, in cases where the allegations involve affiliates of parent universities, it may not be possible to do this. Also, communications with such an entity might be subject to FOIA requests in some cases.

An idea was voiced that such a role could be played by a professional society. An opinion was voiced that something smaller and closer to the institutes might be preferable.

Certain other questions were raised:

- In case of misconduct resulting in a ban from an institute, what is the appropriate duration of the ban? How does one appeal such rulings?
- Legal issues, such as slander, were brought up.
- While an informal system of communication between institutes might be advan- tageous, it may not be the best solution due to potential legal risks; a similar comment applies to formal or informal blacklists.
- There is potential into running into questions of freedom of expression. For exam- ple, a person might make blog posts that make others upset and call for withdrawal of an invitation. How do we handle such things?

In conclusion, MSRI promised to share their policies and procedures with others.

3. JMM Reimagined.

Catherine Roberts (AMS) joined the meeting. She gave a detailed update of AMS plans for the JMM, which AMS will operate without joint involvement of MAA starting in 2022.

If institutes want to contribute, they should alert AMS within the next 6 months. Example contributions include panels, reception, invited addresses. AMS wants JMM to represent mathematics as broadly as possible.

Some MAA activities will continue, including undergraduate poster sessions. AMS is extending the subject classification list to include new entries related to MMA-type activities, including pedagogy, recreational mathematics and so on. AMS invited addresses will be rethought; the Erdos lecture will be moved to JMM. There will be two invited addresses, one on pedagogy and one on diversity. The Porter public lecture will continue, as would project NExT activities. There will be an AMS/MAA joint address (but one rather than two).

AMS wants to be the main organizer of JMM, with others contributing content; this is parallel to how Joint Statistics Meetings (JSM) are run. Having AMS handle the schedule and new ways of merging the schedules of contributors will hopefully decrease the number of bad conflicts. A schedule optimizer might be used.

JSM might in fact be one such contributor, bringing in activities reaching out to statistics and data analysis communities. INFORMS, an operations research institute, is interested in increasing their engagement, making mathematics students more familiar with operations research. They will start with a booth next year, but there is talk of having a special session on operations research.

As another example, Pi Mu Epsilon has agreed to take over the undergraduate poster session, but with one former organizer from MAA staying on board. There are plans for an app that would allow instant feedback and commentary on posters, and for perhaps having several smaller poster sessions.

A new initiative is providing quiet collaboration space for JMM attendees.

In a departure from the current schedule, AMS wants to host an opening reception on Wednesday evening, with the Gibbs lecture moved to precede it. As this is currently the time of the Institutes' reception, the Institutes need to move their reception to another time slot, or discontinue it (or have some booths at the new opening reception). There is also a "first timers and graduate students" reception that currently conflicts with the Institutes' reception.

There was broad consensus to move the Institutes' reception to Thursday, but ask AMS for free advertisement of that reception on Wednesday. It was felt that a separate Institutes' reception is a good idea, especially if we could get more younger participants to attend. It was suggested that AMS be asked to do this at a power breakfast the day after the present meeting.

The Institutes' reception that followed the directors meeting was well-attended and highly successful.

MSRI was asked if they would want to take over the Current Events Bulletin. Some discussion

of the delicacy of the matter ensued; among other things, AMS now publishes a Bulletin volume containing papers by the speakers.

AMS was asked if the employment center would continue, given that the hiring season is shifting towards late to mid-Fall, and lack of MAA participation might mean fewer teaching colleges taking part. AMS stated that the employment fair was always an AMS event; it's not clear if MAA's departure will have an effect. The employment center provides a "Skype Interview" booth addressing concern that participants unable to travel to JMM are at a disadvantage. Additionally, it functions as a safe space for interviews. AMS is trying hard to suppress the practice of interviewing in hotel rooms; this is now prohibited by terms of MathJobs advertisements.

4. VarXiV discussion.

The Perimeter Institute in Waterloo has proposed to create a kind of "ArXiV for videos". The details are unclear, among them whether this service would host links to videos, or the actual videos. ICERM runs the mathinstitutes.org web page and the associated arxive of video links, and would be open to host links to videos at Canadian institutes as well. CIRM is interested in this.

It was decided that the Perimeter Institute be informed of this and asked to get in touch with ICERM. Also, it was suggested that NSF be asked if it would be OK to have videos from Canadian institutes on mathinstitutes.org at the April NSF institutes meeting.

5. Miscellaneous.

CIRM noted that Alejandro Adem, a mathematician, is now head of NSERC.

AIM will take over the organization of the JMM reception next year.

F. PARTICIPANT SUMMARY

In this report, we are reporting on participants of programs that took place between June 10, 2019 through June 12, 2020. We have included the participants of the reunion conference. This report does not include the participants of our RIPS/G-RIPS 2020 summer programs which will be captured in the next reporting cycle.

Also note that we do not collect RSVPs for "Public Lectures".

Table F-1: All Participants' Gender and Ethnicity by Program Type (June 10, 2019 - June 12, 2020)							
Program Type	Total Participants	Gender		Underrepresented Ethnic Groups			
		Female	No. Reporting Gender	Amer. Indian	Black	Hispanic	No. Reporting Ethnicity
Long Programs	222	36	210	0	6	8	**190**
Public Lectures	1	1	1	0	0	0	**0**
Reunion Conferences	19	2	18	0	1	3	**17**
Special Events and Conferences	49	45	45	0	3	7	**44**
Student Research Programs	156	48	118	0	8	17	**126**
Workshops	1935	369	1822	1	69	94	**1721**
Total	**2382**	**501**	**2214**	**1**	**87**	**129**	**2098**
Percent of No. Reporting		22.6%		0.0%	4.1%	6.1%	
			All underrepresented ethnic groups:		*217*	*10.34%*	

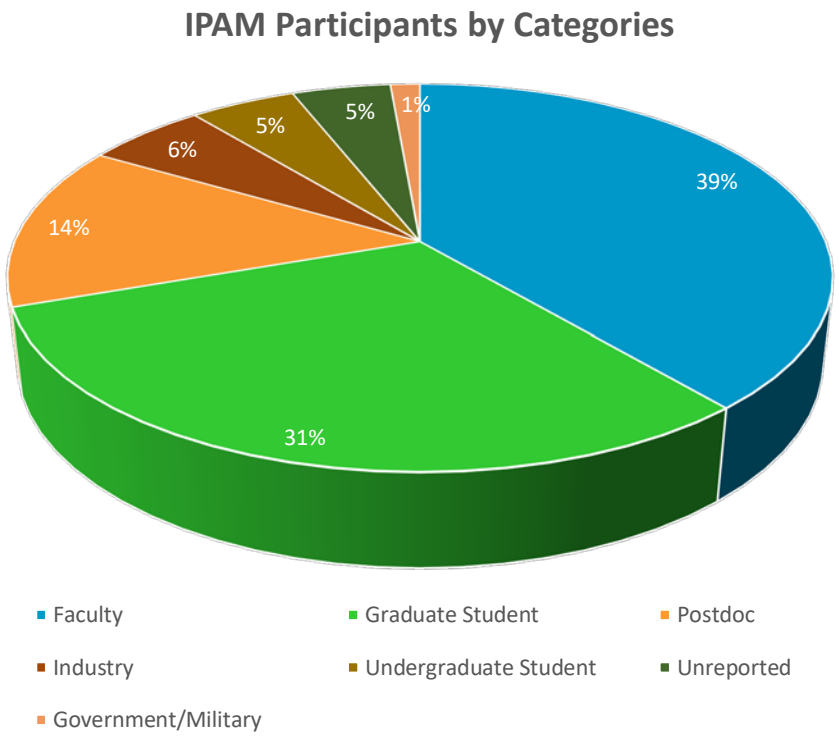
There were 1,201 unique participants for this same period. (Some of the participants attended more than one program, usually multiple workshops within a long program.) Out of those reporting gender, 24% were women. Out of those reporting ethnicity, 10.22% of unique participants were members of an underrepresented ethnic group.

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

It is worth noting that due to safety concerns and the travel restrictions brought on by the COVID pandemic, all IPAM activities, including the spring 2020 long program and its associated workshops, transitioned to a virtual format. This led to a higher number of international participants than we usually experience. The programs in general were quite successful and we received a lot of positive feedback in follow-up surveys.

Table F-2: All Participants' Citizenship by Program Type (June 10, 2019 to June 12, 2020)			
Program Type	**U.S. Citizens & Permanent Residents**	**No. Reporting Citizenship & Residency**	**Percent**
Long Programs	85	222	38%
Public Lectures	1	1	100%
Reunion Conferences	15	19	79%
Special Events and Conferences	38	49	78%
Student Research Programs	85	156	54%
Workshops	788	1935	41%
Total	**1012**	**2382**	**42%**

The majority of IPAM participants were faculty and graduate students. See the pie chart below for the percentage of participants in each category.



G. POSTDOCTORAL PROGRAM SUMMARY

328 postdocs participated in many of IPAM's programs during the reporting period (June 10, 2019 through June 12, 2020). 4 postdocs participants in IPAM's student research program, RIPS, as academic mentors. See tables G-1 and G-2.

Table G-1: Postdocs' Gender and Ethnicity by Program Type (June 10, 2019 - June 12, 2020)

Program Type	Total Participants	Gender		Underrepresented Ethnic Groups			
		Female	No. Reporting Gender	Amer. Indian	Black	Hispanic	No. Reporting Ethnicity
Long Programs	30	7	30	0	1	3	**30**
Reunion Conferences	2	0	2	0	0	1	**2**
Special Events and Conferences	12	12	12	0	1	0	**11**
Student Research Programs	4	0	4	0	0	2	**6**
Workshops	280	69	278	0	11	26	**279**
Total	**328**	**88**	**326**	**0**	**13**	**32**	**328**
Percent of No. Reporting:		27.0%		0.0%	4.0%	9.8%	
		All underrepresented ethnic groups:			*45*	*13.72%*	

Table G-2: Postdocs' Citizenship by Program Type (June 10, 2019 to June 12, 2020)

Program Type	U.S. Citizens & Permanent Residents	No. Reporting Citizenship & Residency	Percent
Long Programs	6	30	20%
Reunion Conferences	2	2	100%
Special Events and Conferences	8	12	67%
Student Research Programs	2	4	50%
Workshops	69	280	25%
Total	**87**	**328**	**27%**

H. GRADUATE STUDENT PROGRAM SUMMARY

Graduate students participated in IPAM's workshops and long programs during the reporting period, as well as in Graduate-level RIPS. A few participated in RIPS-LA as academic mentors. Graduate students often find a compelling thesis topic at an IPAM program, and also frequently make contacts that lead to their first jobs. See tables H-1 and H-2.

Table H-1: Graduate Students' Gender and Ethnicity by Program Type (June 10, 2019 to June 12, 2020)

Program Type	Total Participants	Gender		Underrepresented Ethnic Groups			
		Female	No. Reporting Gender	Amer. Indian	Black	Hispanic	No. Reporting Ethnicity
Long Programs	60	7	60	0	1	2	55
Reunion Conferences	9	1	9	0	1	2	9
Special Events and Conferences	7	7	7	0	0	2	7
Student Research Programs	14	2	8	0	0	1	8
Workshops	645	122	638	1	16	36	611
Total	**735**	**139**	**722**	**1**	**18**	**43**	**690**
Percent of No. Reporting:		19.3%			0.1%	2.6%	6.2%
All underrepresented ethnic groups:					*62*	*8.99%*	

Table H-2: Graduate Students' Citizenship by Program Type (June 10, 2019 to June 12, 2020)

Program Type	U.S. Citizens & Permanent Residents	No. Reporting Citizenship & Residency	Percent
Long Programs	20	60	33%
Reunion Conferences	7	9	78%
Special Events and Conferences	5	7	71%
Student Research Programs	4	14	29%
Workshops	194	645	30%
Total	**230**	**735**	**31%**

I. UNDERGRADUATE STUDENT PROGRAM SUMMARY

Undergraduate students participate in RIPS-LA and RIPS-Singapore (summer student research programs), and RIPS Projects Day (workshop).

Table I-1: Undergraduate Students' Gender and Ethnicity by Program Type (June 10, 2019 to June 12, 2020)

Program Type	Total Participants	Gender		Underrepresented Ethnic Groups			
		Female	No. Reporting Gender	Amer. Indian	Black	Hispanic	No. Reporting Ethnicity
Student Research Programs	76	38	74	0	4	13	82
Workshops	42	19	39	0	2	7	42
Total	**118**	**57**	**113**	**0**	**6**	**20**	**124**
Percent of No. Reporting:			50.4%	0.0%	4.8%	16.1%	
	All underrepresented ethnic groups:				*26*	*20.97%*	

Table I-2: Undergraduate Students' Citizenship by Program Type (June 10, 2019 to June 12, 2020)

Program Type	U.S. Citizens & Permanent Residents	No. Reporting Citizenship & Residency	Percent
Student Research Programs	52	76	68%
Workshops	28	42	67%
Total	**80**	**118**	**68%**

J. PROGRAM DESCRIPTION

The programs are listed in chronological order by start date. The list includes all IPAM programs with start dates between **June 10, 2019 through June 12, 2020**.

Most IPAM workshops include poster sessions; all participants are invited to present a poster, and graduate students are especially encouraged to participate. Most of IPAM's lectures, including lectures during workshops and public lectures, are available online.

We conduct evaluation of all IPAM programs. We administer an online, anonymous survey to all workshop participants. Long programs and our RIPS Program have pre-program and post-

program surveys, which can be matched to compare responses before and after to some questions. We also conduct exit interviews with the junior participants of long programs. The reports are available upon request, and quotes from the surveys for some of the programs are included under the description of the program.

SPECIAL EVENT: Collaborative Workshop for Women in Mathematical Biology. JUNE 17 - 21, 2019.

Organizing Committee
Rebecca Segal (Virginia Commonwealth University)
Blerta Shtylla (Pomona College)
Suzanne Sindi (University of California, Merced)

This workshop will tackle a variety of biological and medical questions using mathematical models to understand complex system dynamics. Working in collaborative teams of 6, each with a senior research mentor, participants will spend a week making significant progress with a research project and foster innovation in the application of mathematical, statistical, and computational methods in the resolution of problems in the biosciences. By matching senior research mentors with junior mathematicians, the workshop will expand and support the community of scholars in mathematical biosciences. In addition to the modeling goals, an aim of this workshop is to foster research collaboration among women in mathematical biology. Results from the workshop will be published in a peer-reviewed volume, highlighting the contributions of the newly-formed groups. Previous workshops in this series have occurred at IMA, NIMBioS, and MBI.

This workshop will have a special format designed to facilitate effective collaborations.

- Each senior group leader will present a problem and lead a research group.
- Group leaders will work with a more junior co-leader, someone with whom they do not have a long-standing collaboration, but who has enough experience to take on a leadership role.
- Additional team members will be chosen from applicants and invitees. We anticipate a total of five or six people per group.
- It is expected that each group will continue to work on their project together after the workshop, and that they will submit results to the Proceedings volume for the workshop.

The benefit of such a structured program with leaders, projects and working groups planned in advance is based on the successful WIN, Women In Numbers, conferences and is intended to provide vertically integrated mentoring: senior women will meet, mentor, and collaborate with the brightest young women in their field on a part of their research agenda of their choosing, and junior women and graduate students will develop their network of colleagues and supporters and encounter important new research areas to work in, thereby fostering a successful research career. This workshop is partially supported by NSF-HRD 1500481 – AWM ADVANCE grant; and by NSF award for SIAM Interdisciplinary Conferences in the Mathematical and Computational Sciences; number: 1757085.

Comments from our participant survey:

"Watching in awe as phenomenal women worked on math and bio. I tried my best to contribute, and although I felt like I still lacked a lot of background to really make a real impact, it was really inspirational to learn from women established in their careers. I definitely have a lot more role models at the end of this trip! The industry panel was helpful in showing me more career opportunities for a mathematical biologist."

"Establishing a new group of collaborators. I've honestly never developed this skill and I'm glad to have had this opportunity."

STUDENT RESEARCH PROGRAM: Graduate-level Research in Industrial Projects for Students (GRIPS) – Sendai 2019. JUNE 17 - AUGUST 9, 2019.

Graduate-Level Research in Industrial Projects for Students (GRIPS) in Japan will offer graduate students in mathematics and related disciplines the opportunity to work on industry-sponsored research problems in Sendai, Japan. Students from the U.S. and Japan will work on cross-cultural teams on research problems designed by industrial sponsors. The projects will be of serious interest to the sponsor and will offer a stimulating challenge to students; most will involve both analytic and computational work. At the end of the program, the teams will present the results of their work and prepare a final report. IPAM will encourage the U.S. students to publish and/or present their research at conferences in the year following the program. English is the only language required for participation.

Round-trip travel to Sendai and accommodations in Sendai are included. Students will also receive a meal allowance and a stipend, and conference support to present their research. (These terms apply to U.S. participants recruited by IPAM. Japanese students may go to this site for information and an application.

This program is partially supported by an IRES grant from NSF's Office of International Science and Engineering.

Projects 1 and 2: **TOYOTA Motor Corporation: Design for the next generation mobility service in suburban areas**

Rapid suburban sprawl in metropolitan areas in Japan has led to the rapid development of peripheral satellite cities. High-speed railway networks and motorways have significantly contributed to improving the connection between established metropolitan areas and these new peripheral cities. But at the same time, due to rapid population growth, sprawled suburban areas with small-scale residential developments were built without schematic road network planning.

As a result, key functions of the city for the citizen's lives, such as commerce, administration, and schools, are diffused to suburban area, on the premise of using private cars. But such developments are not sustainable or desirable as the population ages and as energy conservation

becomes more important. In principle, a higher quality of life can be achieved if key city functions are aggregated in city centers around the main railway stations. This requires better and more efficient public transportation networks in conjunction with small personal mobility.

Mobility-as-a-Service (MaaS) describes an integration of different transportation modes towards mobility solutions that are consumed as a service. Mobility innovation, often called as CASE (C: Connected, A: Autonomous, S: Sharing, E: Electric) could be fully or partially implemented as MaaS. Wider range of demonstration programs and commercial based services are being provided to improve safety, efficiency and convenience of transportation.

There are many studies on MaaS as implementation of CASE, particularly for metropolitan areas where other multiple transportation modes such as rails, metro and buses are available. But at the same time, other areas, where private cars are dominant transportation mode, are not thoroughly investigated. Mobility services for non-metropolitan areas could be different from that for metropolitan areas, due to differences in population density/distribution, transportation demand, and public transportation network.

As an example, Tsukuba city, a city with a population of 237,000 people, and located 60 km northeast of Tokyo, has a private car dependent transportation system. In this project, we organize two groups of students as Group-1 and Group-2 in which the students will design MaaS for practical cases, in particular for university campus and hospital guests, through analyses on existing person-trip and other related data sets.

Project 1: Mobility service for university campus:
University of Tsukuba has a relatively large campus area and a large number of students. The present major transportation modes are buses, bicycles and walks. Students are expected to build a practical planning model to optimize the MaaS for University of Tsukuba campus.

Project 2: Mobility service for hospital guests:
University of Tsukuba Hospital is an advanced treatment hospital in this region. There is a strong need for transportation service for hospital visitors, since the hospital is a few kilometers away from a major transportation hub.Students are expected to build an efficient MaaS planning to optimize the mobility service for hospital guests considering characteristics of several types of patients.

The problems setups and formulations may be different for these targets and the two groups will work independently during the GRIPS-Sendai program. However, exchanging ideas and discussions between these two groups will be highly encouraged and we expect some universal idea for MaaS in the future society. Although there already exist several approaches for this kind of problems, students are expected to find totally new mathematical approaches, descriptors, formulations, solvers, visualizations, operation plans, etc. to be fit for our future society with highly sophisticated mobilities. This project includes sight visits to a mobility exhibition center in Tokyo and University of Tsukuba.

Quote from Julia Vasile, a student on this team:

"I think GRIPS is an incredible experience, it introduced me to a different field in applied mathematics and I learned new skills working on a multidisciplinary team. I think working on a cross cultural team was incredible as well, we really learned so much from each other. GRIPS helped me see that I genuinely enjoy working on multidisciplinary teams and would love to pursue working in a similar environment in the future. Yes, I would absolutely recommend GRIPS. Working with other students from different fields in a different country was incredible and experiencing a new culture made the experience so much greater. The research was interesting, the seminars were a great bonus and the networking was wonderful as well."

Quote from Hannah Thompson, a student on this team:
"The g-RIPS-Sendai 2019 program gave me the opportunity to work on an interesting, applied, socially important problem, develop my scientific communication and mathematical skills, and enjoy a new city and culture for the summer. Working on a team with Japanese and American students from a variety of academic backgrounds was challenging and rewarding, and our diverse perspectives contributed to a better model and more interesting project."

Project 3: **FUJITSU Laboratories Ltd.: Resolving real-world issues by "Digital Annealer"**

Digital Annealer (DA) http://www.fujitsu.com/global/digitalannealer/is a new technology to solve large-scale combinatorial optimization problems instantly. It uses a digital circuit design inspired by quantum phenomena and can solve problems that are tough for classical computers to deal with. Many real-world social issues such as environmental problems, can be regarded as combinatorial optimization problems. The objective of this project is to solve a serious societal issue using DA.

Quantum computing technologies are categorized into two types. One is quantum gate computer, and the other is Ising machine [1, 2]. Quantum gate computers are for universal computing, whereas Ising machines are specialized in searching for solutions of combinatorial optimization problems.

Moreover, there are two types of Ising machines. One is the quantum annealing machine and the other is the simulated annealing machine. The quantum annealing machine searches solutions by using quantum bits which are made of quantum devices such as a superconducting circuit. The simulated annealing machine uses a digital circuit. DA is a type of simulated annealing machines with a new digital circuit architecture that is designed to solve combinatorial optimization problems efficiently. The number of bits (node) of an annealing machine is closely related to the number of combination parameters. Annealing machines with large number of bits (nodes) can solve large-scale combinatorial optimization problems.

Many of the world's social issues can be treated as combinatorial optimization problems that cannot be easily solved by conventional computers when the problem size increases. The applicable fields are chemistry, finance, transportation etc. DA uses the MCMC (Markov chain Monte Carlo) method [3] and the SA (Simulated Annealing) method [4, 5] to solve an Ising

model [6-9] to which a combinatorial optimization problem is converted. This conversion technique is very important to solve problems at high speed.

The general procedure to solve problems by DA is shown as follows.

1) Problem description

2) Formulation to combinatorial optimization problem

3) Re-formulation to Ising model

4) Conversion into QUBO (Quadratic unconstrained binary optimization)

5) Calculation of optimal solution by DA

Fujitsu has launched a DA cloud service in May 2018. The first generation has 1024 bits, all of which are fully connected with 16-bit precision. Although some problems can be handled within this bit size, many of the real-world problems need a larger bit scale. We have developed the second generation service of DA using DAU (Digital Annealer Unit) which has an 8K bit scale. By making both hardware and software enhancements, DA can deal with problems on a scale of 100K bits.

The main aim of this project is to find concrete formulations and efficient algorithms fitted to DA and ultimately find optimal solutions for the combinatorial optimization problems. Students will obtain an experience of thinking about solving social issues in the real world, and observe that many of real-world problems are regarded as combinatorial optimization problems. The project focuses on flow optimization problems among a wide variety of combinatorial optimization problems. Examples of flow optimization problems are as follows:

1) Route optimization for avoiding traffic congestion:

Reduce overall travel time by assigning different routes throughout the city or the entire factory.

2) Optimization of work flow line in a factory to improve productivity:

Up to a 45% reduction in moving distances in a warehouse was achieved by Fujitsu IT Products http://www.fujitsu.com/global/digitalannealer/case-studies/201804-fjit/

Students can select one of these examples and try to find new formulations, or find a new societal problem. Students are expected to look into the problem scale that can be calculated with DA and the combination scales of real problems. It is also expected that the students try to devise a method of obtaining an accurate calculation result. Fujitsu will provide user accounts and computational environments of the new DA machine to the member of this project during the period of GRIPS-Sendai 2019.

Quote from Suzanne Craig, a student on this team:

"I learned a lot about the cultural differences in working in industry versus academia, and had a chance to seriously improve my programming skills. This program has given me non-academic experience for my resume, netted me a much better understanding of what parts of my academic experience are relevant in industry and given me a better understanding of what skills to develop. This program was fantastic both in the actual work and in the chance to explore a new culture. The networking opportunities were also amazing!"

Quote from Christine Hoffman, a student on this team:

"GRIPS has a very high overall educational value, especially the one sponsored by Fujitsu. Our company structured our project really well. We always had a clear, focused goal and had challenging, interesting problems to solve. We also felt that our work was valued and meaningful. It feels really rewarding working on projects directly aimed at solving current problems. I feel it has opened doors for future career opportunities, in terms of both experience and connection. Fujitsu has an office very close to my home in California and I will be attending a symposium there next month thanks to the connections I made at Fujitsu. G-RIPS combines so many unique opportunities: industrial project experience, international collaboration exposure, and university project mentor support. I would highly recommend this program."

Project 4: NEC Corporation: Combinatorial optimization using quantum annealing: Search for proper choices of solvers and evaluation of solutions on combinatorial optimization problems

Recent advent of quantum annealers and digital annealers has brought a breakthrough in solving combinatorial optimization problems fast and accurately. However, size of target problems, for example, obstructs us in directly applying these solvers to the problems, and conventional approaches often outperform the new solvers.

Students are subjected to propose proper choices (or combinations) of the annealers and/or solvers, for Employee Shift Scheduling as an example, which give the most accurate solution in the shortest time. Students are also subjected to develop formulation of corresponding Ising models(*1) and estimate the applicability of each solver. NEC will provide datasets for these evaluations.

1) The quantum and classical annealers provided by D-wave systems Inc.(*2),

2) Solvers based on Xeon servers,

3) Solvers based on GPGPU servers,

4) Solvers based on NEC's Vector machine "SX-Aurora TSUBASA" servers(*3), and their combinations are also available.

(*1)The Ising model, named after the physicist Ernst Ising, is a mathematical model of ferromagnetism in statistical mechanics. The model consists of discrete variables that represent

magnetic dipole moments of atomic spins that can be in one of two states (+1 or −1). The spins are arranged in a graph, usually a lattice, allowing each spin to interact with its neighbors. Quantum annealers and digital annealers try to find the minimum energy state of this model, which corresponds to the optimal combination of the target problem.

(*2) Students can use the classical annealer provided by D-wave systems Inc. to solve the problems Then their Ising models will be executed by industrial mentors on the D-wave quantum annealer.

(*3) https://www.nec.com/en/global/solutions/hpc/

Quote from Juergen Kritschgau, as student on this team:

"Taking a summer to do interdisciplinary work in an industrial setting will have an impact on my career. Whether I stay in academia or move to industry, I want to devote some of my time to interdisciplinary STEM projects with real world applications. GRIPS is a great opportunity to meet young researchers outside of your home department, from many different fields. The cultural exchange aspect is also very fun."

STUDENT RESEARCH PROGRAM: Research in Industrial Projects for Students (RIPS) 2019 – Singapore. JUNE 17 - AUGUST 9, 2019.

In collaboration with the Institute for Mathematical Sciences (IMS) at the National University of Singapore (NUS), IPAM recruits U.S. students to work on cross-cultural teams with NUS students on three projects, each sponsored by a company based in the region. The student team, with support from their academic mentor and industry mentor, will research the problem and present their results, both orally and in writing, at the end of the program. IPAM will encourage the U.S. students to publish and/or present their research at conferences in the year following the program. The sponsors will be announced in April.

The REU program is eight weeks. IPAM provides the U.S. participants with a travel allowance and a stipend of $3,500. Housing and most meals are also included.

U.S. citizens and permanent residents are eligible for RIPS-Singapore. Participants must be tolerant of and adaptable to cultural differences. English is the only language required for participation. The local students, academic mentors and industry mentors will speak English. You must be at least 18 years of age to participate in the program.

The Institute for Mathematical Sciences is in the center of the campus of the National University of Singapore (NUS). NUS is in the centrally located in Singapore with great access to public transportation. Students will stay in residence halls on campus and eat most meals in the campus dining halls. The IMS will provide technical support and offices, and offer some cultural activities.

There were four projects, and all involve some math, statistics, data, and computing:

Sponsor	Title of Project
Google	Mobile Image Classification for Microstrock Photography
Grab	Implementing Differential Privacy in Machine Learning
NUS Saw Swee Hock School of Public Health	Creation of Synthetic Households for Public Health
Nvidia	Exploring a Type Theoretic Library for Python Environment

RIPS Singapore is the international version of our RIPS Los Angeles program.

Quote from Ryan Brill, a RIPS-Singapore student on the Nvidia team:

"I had the best summer of my life at RIPS Singapore. By day, we learned about interactive theorem proving, and by night, we thoroughly explored Singapore. Also, the unique blend of American, Puerto Rican, Singaporean, Vietnamese, Chinese, and Indian students made conversations a lot more interesting. I couldn't ask for anything more. RIPS helped me confirm that I should pursue graduate school."

STUDENT RESEARCH PROGRAM: Graduate-Level Research in Industrial Projects for Students (GRIPS)-Berlin 2019. JUNE 24 - AUGUST 16, 2019.

Graduate-Level Research in Industrial Projects for Students (GRIPS) will offer graduate students in mathematics and related disciplines the opportunity to work on industry-sponsored research problems. Students from the U.S. and Germany will work on cross-cultural teams on three research problems designed by the industrial sponsor. The projects will be of serious interest to the sponsor and will offer a stimulating challenge to students; most will involve both analytic and computational work. At the end of the program, the teams will present the results of their work and prepare a final report. English is the only language required for participation.

Round-trip travel to Berlin and accommodations in Berlin are included. Students will also receive a meal allowance and a stipend. (These terms apply to U.S. participants recruited by IPAM.)

IPAM's partner in Berlin is the newly formed Research Campus MODAL (Mathematical Optimization and Data Analysis Laboratories), which promotes exchange and collaboration between public institutions and private (industrial) partners. The current academic partners of MODAL are the Free University of Berlin (FU Berlin) and the Konrad-Zuse Zentrum für Informationstechnik Berlin (ZIB).

The projects will involve both analytic and computational work. The three 2019 projects were:

Project 1: Deutsche Bahn
Deutsche Bahn (DB) is Germany's major railway company. It transports on average 5.4 million customers every day over a rail network that consists of 33,500 km of track, and 5,645 train stations. DB operates in over 130 countries world-wide. It provides its customers with mobility

and logistical services, and operates and controls the related rail, road, ocean and air traffic networks.

Students will learn to think about railway networks from a planner's perspective. Making up ICE rotations sounds easy at first, but students will soon find out that a lot of constraints have to be taken into account and do not forget about the size of Germany's rail network! This makes finding and understanding suitable mathematical programming models a difficulty of its own. It will be your daily business to deal with huge data sets. Students will write scripts to process the data and extract useful information. The past project assignments included to find out how robust optimization methodology can be incorporated in the optimization process and to develop a rotation plan for the situation that a restricted amount of train conductors is available, e.g. in a strike scenario.

Quote from Joshua Abrams, a student on this team:

"A great experience for gaining insight into industrial research. I gained experience in operations research. One can see how difficult implementing/creating practical solutions can be. I developed a new research in Machine Learning and Big Data Analytics. I had many conversations with the other students who are proficient in it. They could answer any question I had. I also learned about their interests and fields of work. I received advice from older graduate students, learned about the academic system of other institutions, and networked with students, professors, and industry researchers. My work combined many theoretical ideas and became a model that we programmed. I loved learning about Stackelberg Strategies, Mixed Integer Programs, Network Flow Problems, and algorithm complexity. And I got to code a lot. It was great."

Project 2: 1000shapes (Biotechnology)

1000shapes GmbH is a ZIB spin-off that transfers research in life sciences into products for clinical applications. 1000shapes provides advanced solutions in image and geometry processing for 2D and 3D product design, covering the full spectrum from measurement, analysis, planning up to manufacturing. In the medical field, 1000shapes is interested in analyzing medical image based data, such as x-ray, CT or MRT data.

The project will deal with the integrative analysis of large medical data sets coming from a large study about knee osteoarthritis, one of the most common causes of disability in adults. Based on clinical, imaging, genomics and proteomics data the project team will work on and with state-of-the-art algorithms for analyzing this data. The ultimate goal is to integrate the single data sources into a large modelling framework which allows detection / diagnosis of the disease.

Problems and (some) hope: Most of the data coming from available bio-medical data sources, such as images or proteomics data, is ultra high-dimensional and very noisy. At the same time, this data exhibits a very particular structure, in the sense that it is highly sparse. Thus the information content of this data is much lower than its actual dimension seems to suggest, which is the requirement for any following step in this project: the dimension reduction of the data with as little loss of information as possible.

Unfortunately, the sparsity structure of this data is complex, (in most cases) not known a-priori, and usually does not coincide with often assumed patterns such as joint sparsity or Gaussian noise. This means, although the data is highly sparse, the sparsity structure as well as the noise distribution is non-standard. However, specifically adapted dimension reduction strategies such as compressed sensing do not readily exist e.g. for proteomics data.

However, methods exist that allow to identify the sparsity structure of the contained information from very high-dimensional, noisy -omics and imaging data. Once this has been achieved, the next step is the integrating of the (low-dimensional) information into one unified mode. We will use a network-based approach, modelling the various biological levels through a multiplex network coming from existing databases such as known protein/protein or gene/protein interactions. The hope is that this model can shed some light on the mechanisms of osteoarthritis and maybe even allow new ways of early diagnosis of this disease.

Project 3: Deloitte Deutschland

Deloitte provides audit, risk advisory, tax, financial advisory, and consulting services to public and private clients spanning multiple industries; legal advisory services in Germany are provided by Deloitte Legal. With a globally connected network of member firms in more than 150 countries, Deloitte brings excellent capabilities and high-quality service to clients, delivering the insights they need to address their most complex business challenges. Deloitte's approximately 286,000 professionals are committed to making an impact that matters.

The goal of this project is to analyze data anomalies in the context of credit card data. Based on anonymized credit card transactions, time series patterns need to be analyzed in order to detect payment fraud. Based on both statistical and machine learning approaches, competing fraud detection models will be investigated. As a result, the applied approaches will be compared with respect to accuracy, complexity and feasibility. Additionally, the results will be visualized. You will work together with experienced data scientists and you will learn in this project how to visualize and to communicate results within a heterogeneous team. Furthermore, you will get deep insights into the challenges that practitioners are facing, especially when the achieved solutions to such real-world problems need to be implemented into applied risk management processes.

STUDENT RESEARCH PROGRAM: Research in Industrial Projects for Students (RIPS) 2019. JUNE 24 - AUGUST 23, 2019.

The Research in Industrial Projects for Students (RIPS) Program provides an opportunity for talented undergraduates studying math, computer science, and related disciplines to work in teams on a real-world research projects proposed by sponsors from industry or the public sector. The student team, with support from their academic mentor and industry mentor, will research the problem and present their results, both orally and in writing, at the end of the program.

The REU program is nine weeks. IPAM provides each undergraduate student with a travel allowance and a stipend of $3,500. Housing and most meals are also included. RIPS-LA students

will live in residence halls on the UCLA campus and will work at IPAM.

There are 36 students assigned to nine projects. Projects vary, but all involve some math, statistics, data, and computing.

Sponsor	Project
Aerospace	Combining Genetic Algorithms and Machine Learning (CgALM) for Modeling Complex Systems
Advanced Micro Devices	Automating Artifact Detection in Video Games
Air Force Research Lab	Attractor Reconstruction and Empirical Parameter Inference for Hydrogen-Oxygen Chemistry
Alibaba	Online Algorithms for Allocating Products to Users
Amazon	Obstacle Avoidance of Autonomous Vehicles
Google	Risk Assessments and Measurements of Privacy Leaks within Google's Ads Data Hub
GumGum	Fusing Visual and Textual Features for Content Safety Classification
HRL Laboratories	A Framework to Determine Constitutive Parameters for Mesoscale Modeling of Metal Alloys
Lawrence Livermore National Laboratory	A Parallel-in-Time Multigrid Approach to Constrained Optimization

We collected the following comments from students in RIPS2019 on the post-program survey:

"During the RIPS program, I could learn a lot from my teammates, from the articles we read as well as from our industry mentor. Overall I am very satisfied with the educational aspect of my project. RIPS program gave me insight into the industry. I will definitely use that experience when choosing my future career. I learned a lot about graduate school as well. I would definitely recommend RIPS to everyone! Working with the international and very helpful team was extremely valuable. Especially exciting was a fact that we were working on a real problem of our sponsor." Magdalena Niescior, Amazon team.

"RIPS is a program of unparalleled education value. For students like, who are torn apart between academia and industry, RIPS came in at the most perfect time to provide the best combination of both. It teaches you how to do research from an applicative point of view and how to create products that are in compliance with state-of-the-art approaches. It enables you to explore more, take chances while still produce results at the end by pushing your imagination and maintaining a work-life balance. Another educational value it teaches you is to work in teams and learn from each other's abilities through collaborative work. Overall, it was wholesome. I would 10/10 recommend RIPS to other UG students. I believe RIPS teaches you important life skills at the most perfect time. It teaches you how to work with cross-domain topics, with people from various inter-related fields and diversities in a collaborative and positive set-up. It teaches you how to voice your opinion and the importance of hearing people out. It gives you the freedom to explore, while providing you with all the resources and support one would need to produce good results. It is not just academic oriented, but like life, it is wholesome. Struggle, work and have fun." Shreya Gupta, Google-LA team.

“RIPS was a great opportunity to learn to work on a team and to work as part of a community of some really smart and hard-working people. I hadn't had the chance to work on a group project of this size before.” Travis Leadbetter, HRL team.

“RIPS gave me a great feel for what a career in industry will look like which is definitely one of the things I was looking to get out of this program. I had a wonderful time at RIPS. Not only did I learn a lot, but also the cultural interactions with other students were AMAZING. I feel very fortunate that I was able to participate in this program.” Parmida Davarmanesh, AMD team.

“Even though my project was not initially related to the field I am studying, the knowledge I gained was invaluable. RIPS has encouraged me to apply to UCLA for public health in Biostatistics. While challenging, the people make it worth it. You learn so much about yourself and about different fields, it's definitely worth it!” Sarika Aggarwal, Google-LA team.

“RIPS has really taught me a lot in terms of research and presentation skills. I have also learned useful knowledge in the field of optimization and numerical methods that apply well to solving real-world problems. think RIPS overall is an awesome experience. And I gained immensely from the work we did and the friendships created with fellow students.” Qinyi Chen, Alibaba team.

“I learnt what it is like to work full time on a research project as this is my first real research experience. I also learnt a lot about specific mathematical topics which were relevant to my project. RIPS confirmed to me that a research career is what's right for me. It has also influenced the subjects I want to pursue for my research. I was fairly undecided at the beginning and I'm still not fully sure but I would certainly like to look more into the topics of numerical analysis and high performance computing, which were the main topic of my project. I would recommend RIPS to any undergraduate students in areas like maths, physics or computer science who are interested in research careers. The projects are extremely interesting in both their mathematical nature and their real world applications. It is a unique experience to have an REU based on industry research as most are more academic so you will not get the same experience anywhere else. Aside from the work it is a diverse and social group of people so you will enjoy all of your time both in work and during free time.” Eric Neville, Lawrence Livermore National Lab team.

“RIPS is a research program that emphasizes all major skills needed for a career in research: technical research skills, communication and report writing skills, and working effectively within diverse groups of people. These nine weeks have been extremely formative for me, and I am sure for others as well. I would highly recommend RIPS to other undergraduate students. The research skills, presentation skills, and social skills one will develop at the program will be of great use in the future of any aspiring mathematician. This has been the most organized and well thought out research program I have been a part of. I will truly miss and cherish my time spent here. Thanks for everything!” Tom Overman, Lawrence Livermore National Lab team.

“I don't think that RIPS program changed my career choice, but it definitely helped me to gain a lot of skills for my future work (for example writing the report, preparing for the presentation). Also, I am grateful for the time that professors (Dima and Susana) and academic mentor spent

with us talking about all questions I had related to research, graduate schools and life in general." Dubravka Kutlesic, Amazon team.

"Through RIPS I've improved my understanding of how industry and academia differ. I've also decided to pursue my career further towards theoretical research. I would especially recommend RIPS to students who are not sure about whether to pursue their career in the industry or in academia." Dominik Kufel, Alibaba team.

"MY RIPS experience now dictates my search in the quality of an REU next year and in the research, I will do for all my academic career." Rebecca Lopez, Air Force Research Lab team.

"RIPS is an excellent, well-organized program that introduced me to the wide-ranging, fascinating world of industrial mathematics. Prior to participating in RIPS, I thought that the only path for pursuing "real" mathematics research is to follow a traditional academic career; now I have seen that math pervades industry and all areas of human endeavor -- to quote the IPAM tagline, math truly changes everything. RIPS has broadened my perspective on the variety of careers available in mathematics research, and has strengthened my determination to pursue a graduate degree. Moreover, my particular project introduced me to data-driven research methods that combine dynamical systems theory with information-theoretic and algorithmic approaches. I learned a lot this summer and now feel better prepared to choose a specialization in graduate school. I would wholeheartedly recommend RIPS to all undergraduate students who are interested in real-world applications of mathematics and computer science. Few, if any, other programs provide the perfect balance between theoretical research and industrial application." Mykhaylo Malakhov, Air Force Research Lab team.

"I woke up every day with the desire to work at IPAM, not only for we are given all the resources we need to conduct meaningful research in an industrial project, but also because colleagues, staff and faculty from all around the world become exceptional friends and mentors. You'll have the time of your lives as you have the freedom to conduct research in applied mathematics that is also curiosity driven. I'm grateful and honored to be part of RIPS, thank you for making this possible." Luis Rodrigo Leonardo Castellanos, GumGum team.

"RIPS validated my plans to go to industry after graduate school." Samuel Tan, Amazon team.

"I strongly believe that RIPS will have an impact on the career I choose. My perspective of graduate education has changed in a positive way. I will strongly encourage undergraduate students to participate in RIPS. This program is very different from other REUs as it provides valuable experience of how things work in industry to the students at undergraduate level which helps them to plan out very early in their careers." Mohammed Uzair, GumGum team.

"RIPS is fantastic. I came in knowing next to nothing about optimization or space, and nine weeks later, I'm astonished at what I now know and what my team has accomplished. RIPS is really a unique opportunity to see mathematics in industry in action, and I'm incredibly grateful to have been a participant. With support and guidance from our industry mentor, we as a team decided on our project goals and schedule, what areas and techniques to explore within our project topic, and how to design our algorithms. I truly felt that we had ownership over our

project. RIPS projects are hard, but with support and guidance from IPAM and our sponsor, tackling them is fun. I loved RIPS, and I would absolutely recommend it to other undergraduate students. The community with other RIPS participants is fantastic, from exploring LA and the surrounding area to playing volleyball on campus. I discovered a new area of mathematics I didn't even know existed, and I'm hoping to take classes or pursue further research in it. I was honestly excited to be at work every day." Rachel Duquette, Aerospace Team.

"RIPS was a very academically enriching experience. I learned so much about working in a team of diverse students, and I also feel well prepared to tackle real-world industrial problems in math in the future. My RIPS experience has strongly influenced my desire to attend graduate school. I realized that research is the perfect career choice for me, and now I'm certain I want to keep learning and contributing research in applied math. RIPS provides an invaluable opportunity to meet and work with other students from around the world, something I likely would not have gotten to do at my home institution or in other research programs." Amber Hu, GumGum team.

"RIPS was an incredible opportunity to gain experience in research and academic settings, as well as to see the dynamics of working in an industry setting with industry goals. I learned so much in RIPS not only with regards to the specific field of research, but also in how to effectively present and write-up my results, as well as how to work on a team. Before coming to RIPS I was unsure of whether or not I wanted to pursue graduate studies, and was only considering a Master's degree. However, now I am certain that I would like to pursue graduate school and am primarily looking at PhD programs in statistics. I would definitely recommend RIPS to other undergraduate students who have an interest in interdisciplinary research in mathematics/statistics/computer science. I would also add that this program is especially valuable for students that might be unsure about their future plans with regards to graduate studies, industry vs. academia, etc." Jacob Chang, Aerospace team.

"RIPS is a great program for anyone interested in expanding both their theoretical knowledge and their ability to apply that knowledge to real-world problems." Abishek Shivkumar, Air Force Research Lab team.

"I would recommend RIPS to undergraduates both with and without prior experience. The program truly does a wonderful job supporting you intellectually and technically with its structure, and I definitely walked away excited to conduct more research!" Tongyu Zhou, Aerospace team.

"I think it's a great choice of REU because it can help students make a decision between industry and academia, and experience teamwork and research." Jennifer Pi, HRL Lab team.

"[RIPS] told me that I do want to purse a more research intense career. Further, as pm (program manager), I learned that I enjoy taking leadership positions and managing teams. The program is amazing, and certainly one of the highlights of my undergraduate research experience." Joseph Munar, Lawrence Livermore National Lab team.

"The overall educational value of RIPS is very high, it taught me a lot about the research process, technical writing, and presenting. I feel much more prepared for grad school now then I

did before the program. My RIPS experience has helped me prepare for my grad school applications. The information I learned about the application process from talking with Dima and Susana was great but the more important thing was the community that I got to be a part of. I do not know many people from my school who are pursuing grad school so to get to become friends with so many other people with the same goals as me gave me a lot of confidence that I wasn't in this alone." Miguel Fuentes, Google-LA team.

"RIPS was overall very educationally valuable. The program was a great combination of teamwork and mathematical problem-solving. I was not considering graduate school in mathematics (pure or applied) at all before this program, but now I am because RIPS exposed me to a lot of interesting math problems and made me more confident in my math abilities. I would recommend RIPS to other undergraduate students because RIPS taught me how to approach a difficult problem in order to solve it and how to work effectively with a team." Andrea Boskovic, Alibaba team.

"RIPS is a very good program, providing students large scope of research area. This is my first applied math research. I feel the difference between applied and pure math. In addition, I think pure mathematicians can also contribute to the industrial research a lot." Zijie Zhou, Alibaba team.

S**UMMER SCHOOL: Computational Genomics Summer Institute 2019 (cosponsor).** JULY 10 – AUGUST 2, 2019.

Organizing Committee
Jessica (Jingyi) Li (University of California, Los Angeles)
Sriram Sankararaman (University of California, Los Angeles)
David Koslicki (Pennsylvania State University)

Over the past few decades, technological developments resulted in the accumulation of large genomic data even within a single experiment. The analysis of these data led to many novel discoveries and medical applications. For this reason, the majority of the biotechnology and pharmaceutical companies today, as well as many labs in academia, include experts in such biological data analysis that is emerging from these technologies. These experts have domain expertise in subfields of genomics such as cancer genomics, statistical genetics, protein structure prediction, computational medicine, metagenomics, and others.

The analysis of these datasets requires the development of methods that are domain-specific. For this reason, over the years, many communities that are dedicated for specific subfields of genomics have emerged. Unfortunately, this resulted in smaller overlap between the different sub-domains, hence for example the statistical genomics community may have a very minimal overlap with the metagenomics community. CGSI was formed in order to bridge this gap; it is a methods-oriented program, where our goal is to create interactions between the different fields of research in computational genomics in a relatively informal setting.

In order to achieve this goal, we structure CGSI in a very non-typical way, resulting in its own unique culture. Specifically, CGSI is a fusion of a summer school and a regular conference. It has the characteristics of a conference since it brings together hundreds of researchers and trainees over a period of a month, and the researchers showcase their latest research. On the other hand, it has the characteristics of a summer school since it is a month long program that involves a combination of tutorial (broader talks that include overview of the field) and research talks, and the talks are long enough to allow for in-depth discussion. Importantly, in CGSI we particularly emphasize the need for interaction between the different individuals; we include social activities that result in 'ice-breakers', including a retreat in the mountains of Los Angeles, picnic at the beach, and sport activities that involve both the faculty and the trainees. It is a very informal setting with long coffee breaks that allow for ample discussions.

We are very proud of the faculty in the CGSI community; it is clear that everyone that joins these meetings view them as an opportunity to be part of a larger community. The vast majority of the faculty that join CGSI take an active part in the social events, they spend at least a week at CGSI, and they make an effort to interact with other faculty and trainees from other fields in computational genomics in order to create a sense of a larger methods-based community. We welcome to our community both new and established researchers who are interested in methods development for genomics and medical applications, and who would like to become part of a larger, friendly and intellectually intriguing community.

The institute has its roots in a program called "Mathematical and Computational Approaches in High-Throughput Genomics" which was held in the Institute for Pure and Applied Mathematics (IPAM) that was led by Russ Caflisch at the time. Many of the current CGSI faculty were involved in this program. CGSI was then founded in 2015, when Eleazar Eskin (UCLA), Eran Halperin (UCLA), John Novembre (The University of Chicago), and Ben Raphael (Princeton University) joined forces with the IPAM, with the objective of developing an annual flexible program for improving education and enhancing collaboration in genomics and related fields.

WORKSHOP: RIPS Projects Day, August 22, 2019

The nine RIPS-LA teams presented their industry-sponsored research on the projects listed above. Representatives of the industry sponsors attend, and guests included friends and family members of the students, IPAM supporters, and members of UCLA's math and science community.

LONG PROGRAM: Machine Learning for Physics and the Physics of Learning.
SEPTEMBER 4 - DECEMBER 8, 2019.

Organizing Committee
Steve Brunton (University of Washington)
Cecilia Clementi (Rice University)
Yann LeCun (Facebook, Canadian Institute for Advanced Research)
Marina Meila (University of Washington)

Frank Noe (Freie Universität Berlin)
Francesco Paesani (University of California, San Diego)

Machine Learning (ML) is quickly providing new powerful tools for physicists and chemists to extract essential information from large amounts of data, either from experiments or simulations. Significant steps forward in every branch of the physical sciences could be made by embracing, developing and applying the methods of machine learning to interrogate high-dimensional complex data in a way that has not been possible before.

As yet, most applications of machine learning to physical sciences have been limited to the "low-hanging fruits," as they have mostly been focused on fitting pre-existing physical models to data and on discovering strong signals. We believe that machine learning also provides an exciting opportunity to learn the models themselves–that is, to learn the physical principles and structures underlying the data–and that with more realistic constraints, machine learning will also be able to generate and design complex and novel physical structures and objects. Finally, physicists would not just like to fit their data, but rather obtain models that are physically understandable; e.g., by maintaining relations of the predictions to the microscopic physical quantities used as an input, and by respecting physically meaningful constraints, such as conservation laws or symmetry relations.

The exchange between fields can go in both directions. Since its beginning, machine learning has been inspired by methods from statistical physics. Many modern machine learning tools, such as variational inference and maximum entropy, are refinements of techniques invented by physicists. Physics, information theory and statistics are intimately related in their goal to extract valid information from noisy data, and we want to push the cross-pollination further in the specific context of discovering physical principles from data.

WORKSHOP: Machine Learning for Physics and the Physics of Learning Tutorials.
SEPTEMBER 5 - 10, 2019.

Part of the Long Program "Machine Learning for Physics and the Physics of Learning"

Organizing Committee
Steve Brunton (University of Washington)
Cecilia Clementi (Rice University)
Yann LeCun (New York University, Canadian Institute for Advanced Research)
Marina Meila (University of Washington)
Frank Noe (Freie Universität Berlin)
Francesco Paesani (University of California, San Diego)

The program opens with four days of tutorials that will provide an introduction to major themes of the entire program and the four workshops. The goal is to build a foundation for the participants of this program who have diverse scientific backgrounds. The tutorials will focus on the theoretical and conceptual foundations of machine learning, as well as several of the application areas that will be discussed during the program.

For those participating in the long program, please plan to attend Opening Day on September 4, 2019, as well. Others may participate in Opening Day by invitation from the organizing committee.

WORKSHOP I: From Passive to Active: Generative and Reinforcement Learning with Physics. SEPTEMBER 23 - 27, 2019.

Part of the Long Program "Machine Learning for Physics and the Physics of Learning"

Organizing Committee
Alán Aspuru-Guzik (Harvard University)
Frank Noe, Chair (Freie Universität Berlin)
Ankit Patel (Rice University)
Katya Scheinberg (Lehigh University)
Ruth Urner (York University)

How can we design a costly experiment in an informationally optimal way? How can we generate complex structures under strong physical constraints? How should we structure the stages of learning or observing in a changing, reactive or adversarial environment? This workshop will address these questions by means of active learning, sequential decision making, experimental design, reinforcement learning, interactive learning or generative learning. In other words, the workshop will examine how to plan experiments in order to use information in a cost-optimal way. It will also include the application of these modalities to training complex models, such as deep architectures, and the transfer of these ideas to the generation of physically-relevant complex structures such as chemical structures, molecular structures, scalar or vector fields in fluid dynamics or electrodynamics, proposal steps for Markov chain Monte Carlo of physical systems etc. In all of these areas, we would like to be able to generate fairly complex structures that have rather strict physical constraints (such as conservation laws, differentiability, smoothness, etc). The constraints make generation of valid structures harder on one hand, but they may also be used to guide the search.

Comments from our participant survey:

"The staff was super helpful. I love how fast the materials made it into the website. The workshop ran extremely smoothly and I had an excellent time. I will recommend IPAM workshops to my colleagues in industry and academia."

"Video Recording is great. Staff is nice and friendly. Speakers' level outstanding! Much appreciated, great job IPAM! Looking forward for the next ones."

WORKSHOP II: Interpretable Learning in Physical Sciences. OCTOBER 14 - 18, 2019.

Part of the Long Program "Machine Learning for Physics and the Physics of Learning"

Organizing Committee
Cecilia Clementi (Rice University)
Kyle Cranmer (New York University)
J. Nathan Kutz (University of Washington)
Francesco Paesani (University of California, San Diego)
Andew White (University of Rochester)

An assumption that is often made in physical sciences is that an apparently high-dimensional process can be approximated by a small number of free parameters. Previous IPAM programs have focused on exploring this assumption by using paradigms such as dimension reduction, sparse recovery, clustering and representations with hidden variables, and graphical representation of conditional independence (graphical models). This workshop will have a different focus and will explore representation learning for physical systems, i.e. learning qualitative physics by structures such as the above that have physical meaning. The ultimate goal is not to be limited to find a structure in the data, but to be able to interpret it in terms of fundamental physical principles. The workshop will include methods to summarize and interpret a complicated learned model (e.g. deep neural network) by interrogating this model about what and why it has learned (e.g. relevance propagation and sensitivity analysis).

This workshop included a poster session.

Comments from Twitter:

“More talks up. This workshop is just ridiculously good. I am blown away by the quality of talks with this @ipam_ucla program. Proud to be one of the organizers.”

“Fantastic job by the organizers of @ipam_ucla’s workshop “Interpretable Learning in Physical Sciences!” I can say it’s the most interesting and exciting conference I’ve ever been to.”

WORKSHOP III: Validation and Guarantees in Learning Physical Models: From Patterns to Governing Equations to Laws of Nature. OCTOBER 28 - NOVEMBER 1, 2019.

Part of the Long Program “Machine Learning for Physics and the Physics of Learning”

Organizing Committee
Joan Bruna (New York University)
Steve Brunton, Chair (University of Washington)
Eurika Kaiser (University of Washington)
Marina Meila (University of Washington)
Christof Schuette (Freie Universität Berlin)

Research in physics is often concerned with establishing the governing equations of a dynamical system. As systems become increasingly complex and data more abundant, machine learning (ML) is becoming a standard approach for modeling physics, yet the full power of statistical

learning is rarely used. Consequently, the learning algorithms offer no guarantees and the resulting discoveries need external human validation. For the same reason, results do not generalize from one problem to the next; a human expert must inspect and interpret the results, and this interpretation is the transferable knowledge. The human expert does not benefit from specialized data analytic tools to separate the artifacts introduced by the algorithm from the data features. In other words, the ML algorithms are black boxes from the point of view of the physicist.

This workshop will showcase how to employ mathematical aspects of statistical / information theoretic approaches in ML for the discovery of physical laws from data. Offering statistical guarantees along with the learned models is critical in physics and in areas such as aeronautics, climate science, chemistry, biology, and robotics. We will consider model selection, robust statistics, model-free and adaptive learning, and model validation in the context of both static and dynamic models, such as equations of motion.

This workshop included a poster session.

Comments from our participant survey:

“Very excellent workshop.”

“I think there was a variety of talks related to the applications of the techniques discussed at the workshop. It would be selfish of me to think that all of the techniques would be directed to my field, speaking as a computational physicist. Instead, it was actually enlightening to be forced to think outside of my field as it forces me to think about my problems from a different perspective. But, I was able to extract some methods that could be useful for my own field.”

“IPAM workshops are consistently excellent. Keep up the good work!”

SPECIAL EVENT: Modern Math Workshop (organized by MSRI). OCTOBER 30 – 31, 2019.

Organizing Committee
Elvan Ceyhan (SAMSI - Statistical and Applied Mathematical Sciences Institute)
Christian Ratsch (University of California, Los Angeles; Institute of Pure and Applied Mathematics (IPAM))
Michael Singer (MSRI - Mathematical Sciences Research Institute)
Ulrica Wilson (Morehouse College; Institute for Computational and Experimental Research in Mathematics (ICERM))

As part of the Mathematical Sciences Collaborative Diversity Initiatives, six mathematics institutes are pleased to host their annual SACNAS pre-conference event, the 2019 Modern Math Workshop (MMW). The Modern Math Workshop is designed to encourage undergraduates from underrepresented minority groups to pursue careers in the mathematical sciences, and to build

research and networking opportunities among undergraduates, graduate students and recent PhDs.

The workshop includes two mini-courses aimed at undergraduates, research sessions aimed at graduate students and recent PhDs, a panel addressing professional issues of interest to both, a reception open to all participants, and a Q&A with NSF Math Institute representatives.

The MMW is part of the SACNAS National Conference and begins with registration at noon on Wednesday, October 30 and ends at noon on Thursday, October 31.

WORKSHOP: Deep Fakery: Mathematical, Cryptographic, Social, and Legal Perspectives.
NOVEMBER 15 - 16, 2019.

Organizing Committee
Jacob Foster (University of California, Los Angeles)
Mark Green (University of California, Los Angeles)
Alicia Solow-Niederman (University of California, Los Angeles)

The authentication of information lies at the core of our legal system, our EF2019_imgdemocracy, and many other aspects of our society. Is a photograph real, or has it been doctored? What about a video? Can we believe what we see? When the apparent authenticity of a piece of information can too easily be cast into doubt—and there is no accepted means to verify its provenance and reliability—we face a society-wide crisis. Coupled with the erosion of trusted sources, and fueled by current developments in machine learning, the proliferation of automated methods for fabricating information (so-called “deep fakes”) represent a new stage in the “arms race for truth.” Indeed, one of the most significant unintended consequences of AI advances may be their use as a powerful weapon in this struggle. Escaping the arms race dynamic will require the development and deployment of technical, social, and legal countermeasures. What should those countermeasures be? And who should deploy them? Our workshop aims to explore such questions.

To untangle the mathematical, computer science, sociological, legal, and policy issues and begin to craft practical interventions, we will bring together people with a diverse set of expertise such as:

—How to create fake images, video and audio, and how to detect such fakery;

—How cryptographic methods might proactively ensure the authenticity of information and make tampering or fabrication easier to detect;

—How instances of fakery spread as social phenomena and undermine consensus understandings;

—How the proliferation of fabricated information affects broader civic discourse, and to what extent individual education and/or market, legal, or technical interventions can counter harmful effects;

—How ex ante statutes or regulations and/or ex post penalties might alter malicious actors' incentives;

—How national and global freedom of expression considerations, dignitary rights, privacy law (both statutory and common law), and bodies of existing legal code such as the rules of evidence might enhance our understanding of the issues and/or inform potential interventions.

This workshop included a poster session.

WORKSHOP IV: Using Physical Insights for Machine Learning. NOVEMBER 18 - 22, 2019.

Part of the Long Program "Machine Learning for Physics and the Physics of Learning"

Organizing Committee
Yann LeCun (Facebook, Canadian Institute for Advanced Research)
Matthias Rupp (Fritz-Haber-Institut der Max-Planck-Gesellschaft)
Lenka Zdeborová (Commissariat à l'Énergie Atomique (CEA))
Riccardo Zecchina (Bocconi University)

In this workshop we will explore how to use physical intuition and ideas to design new classes of machine learning (ML) algorithms. Physics-inspired sampling algorithms could be used to train ML structures or sample the hyper-parameter space (e.g. deep Neural Networks). Additionally, physics-based models such as Ising/Potts models or energy-based models have influenced ML inference frameworks such as Markov Random Fields and Restricted Boltzmann Machines, and we want to continue the discussion to facilitate this innovation transfer. Finally, physical insight could be used to enhance learning in the situation of scarce data by enforcing smoothness, differentiability or other physical properties relevant to a given problem. We will also explore the use of Koopmans' theorem to design learning algorithms for dynamical systems. Finally, we will discuss and try to promote theories from physics and mathematics that can help us understand and systematize the deep learning framework.

This workshop included a poster session.

WORKSHOP: Machine Learning for Physics Culminating Workshop at Lake Arrowhead. DECEMBER 3 - 8, 2019.

Part of the Long Program "Machine Learning for Physics and the Physics of Learning"

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

The final workshop in the long program, "Machine Learning for Physics and the Physics of Learning," which was 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 futures projects. Many of the collaborations and interactions that were formed during the program had a chance to deepen.

Comments from our participant survey:

"The opportunity to meet and discuss research and other mathematical topics with participants from the other programs is important. It was good to have some free time for these discussions and also to have the last evening to socialize. Please keep the last evening free in the future."

"Excellent program with a good balance of topics."

REUNION CONFERENCE: Quantitative Linear Algebra Reunion Conference I. DECEMBER 3 – 8, 2019.

The reunion conference was organized by the original long program organizing committee.

This was the first reunion conference for participants of the spring 2018 long program "Quantitative Linear Algebra." 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.

WORKSHOP: Theory and Computation for 2D Materials. JANUARY 13 - 17, 2020.

Organizing Committee
Pilar Ariza (University of Sevilla)
Eric Cances (École Nationale des Ponts-et-Chaussées)
Efthimios (Tim) Kaxiras (Harvard University)
Mitchell Luskin (University of Minnesota, Twin Cities)
Dionisios Margetis (University of Maryland)
Noa Marom (Carnegie Mellon University)
Michael Weinstein (Columbia University)

The unique electronic, optical, and mechanical properties of 2D materials have sparked an extraordinary level of experimental, theoretical, and computational activity in the materials science and physics communities. Interest in the mathematics community has recently emerged to develop rigorous foundations, improved models, and computational methods. This IPAM workshop will enable exchanges among the mathematics community and the theoretical and computational materials science and physics communities working on 2D materials. Topics to be discussed include electronic structure, transport, plasmonics, and mechanics.

The workshop included a poster session.

Comments from our participant survey:

"I not only learnt a lot of new knowledge, but also found new topic for my research and collaboration from this workshop. In addition, I resolved some research problems which have been puzzling me for a long time after I discussed with some participant and speaker within the workshop."

"The talks were highly relevant with a wide range of topics within the discipline."

"talks were appropriate and relevant. Very valuable exchanges."

"I found some potential future collaborations with some speakers after their talks. Also, I resolved my current research problems after I discussed with other participants within this workshop."

"This is a wonderful workshop that sparks a lot of insightful discussions. Thanks to all the organizers and staff for making this possible."

WORKSHOP: Emerging Opportunities for Mathematics in the Microbiome. JANUARY 23 - 24, 2020.

Organizing Committee
Jonathan Jacobs (University of California, Los Angeles)
Emeran Mayer (University of California, Los Angeles)
Jeff Miller (University of California, Los Angeles)
Stanley Osher (University of California, Los Angeles)
Aydogan Ozcan (University of California, Los Angeles)
Paul Weiss (University of California, Los Angeles)

The study of the human microbiome has seen an explosive growth in the past decade, primarily driven by advances in sequencing technologies and computational resources.

The microbial cells that colonize the human body, including intestinal and skin environments, are at least as abundant as our somatic cells and contain a much greater number of genes than the human genome. However, different people harbor radically different collections of microbes and we do not yet understand how the variation within a person over time or that between different people influences wellness, the preservation of health or the risk for or onset of disease. Experimental studies reveal possible patho-physiologies linked to abnormalities in the microbiome such as cancer, diseases of the skin, metabolism, malnutrition, food allergies, autoimmune and psychiatric disorders. Many of these have been increasing in prevalence during the past 50 years and have been linked to changes in lifestyle, diet, the use of antibiotics and the resulting decline in microbial diversity.

Current concepts about the health of the microbiome are based on ecological and systems biological concepts of diversity, abundance, resilience and resistance to perturbations. In this workshop we will explore mathematical approaches to better frame, explore and attempt to answer several fundamental questions related to the microbiome. For example, how can we quantitatively define a healthy microbiome? What inputs or environmental changes will it respond to? How do these responses change in individuals over time, as the microbiome reproduces, or as a function of its early phases (prenatal to the first three years of infancy)? Are there memory effects? Can we identify target parameters or metrics that can be optimized to say, engineer an optimal aspect of the microbiome? We will also discuss state of the art microbiome data (metagenomics, metatranscriptomics, metabolomics), comprehensive metadata (diet, medication use, life style, brain imaging, autonomic nervous system recording, etc) and possible big data analysis of the above datasets.

WORKSHOP: Deep Learning and Medical Applications. JANUARY 27 - 31, 2020.

Organizing Committee
Ben Glocker (Imperial College)
Gitta Kutyniok (Technische Universität Berlin)
Marc Niethammer (University of North Carolina)
Stanley Osher (University of California, Los Angeles)
Daniel Rueckert (Imperial College)
Jin Keun Seo (Yonsei University)
Michael Unser (École Polytechnique Fédérale de Lausanne (EPFL))
Jong Chul Ye (Korea Advanced Institute of Science and Technology (KAIST))

Rapid advances in deep learning techniques are starting to revolutionize medical imaging. Radiology, disease detection, and tissue imaging are all expected to be facilitated by automated image analysis programs in the near future. Many new interdisciplinary research questions arise; finding solutions with practical significance requires input from mathematicians, bio-physicists, and computational engineers. This workshop aims to bring together researchers from different backgrounds to explore this new frontier of science.

The workshop will include a poster session.

Comments from our participant survey:

“I appreciate your preparement of this workshop. It was very helpful to me and I was very satisfied with eveything, talks, web page and food. It'a not easy to learn all these interesting topics around me, but I could get a lot of idea for future studying here. I hope IPAM keep organize these kinds of workshops. Thank you so much.”

PUBLIC LECTURE: Green Family Lecture Series: "Can We Use Genomics to Better Understand and Treat Cancer?" by Jill Mesirov. JANUARY 27, 2020.

This lecture is open to the public. No registration was required, therefore, the attendees do not appear in our participant list.

Speaker Bio:
Jill Mesirov is associate vice chancellor for computational health sciences and professor of medicine at UC San Diego School of Medicine. As associate vice chancellor, Mesirov is responsible for the overarching strategy for computational health sciences and research computing at UC San Diego School of Medicine. She is a member of the UCSD Moores Cancer Center, where she serves as co-lead for the structural and functional genomics research program.

Abstract:
The sequencing of the human genome and the development of new and more economical methods for acquiring biological data have changed the face of medical research. The use of mathematical and computational approaches is critical to take advantage of this explosion in biological information. I will describe some recent discoveries resulting from the analysis of these data and their implications for the understanding and treatment of cancer.

PUBLIC LECTURE: Green Family Lecture Series: "Computational Genomic Approaches to the Understanding and Treatment of Cancer" by Jill Mesirov. JANUARY 28, 2020.

This lecture is open to the public. No registration was required, therefore, the attendees do not appear in our participant list.

Speaker Bio: See above.

Abstract:
The acceleration of data acquisition and the availability of increasing amounts of both genetic and functional data, is changing the face of biomedical research. Computational approaches can take advantage of these data and bring the promise of improved understanding and treatment of disease. We will describe some of the methods and recent discoveries that are helping to better understand and treat cancer, and their translation to the clinic.

WORKSHOP: Asymptotic Algebraic Combinatorics. FEBRUARY 3 - 7, 2020.

Organizing Committee
Jonathan Novak (University of California, San Diego)
Igor Pak (University of California, Los Angeles)
Greta Panova (University of Southern California)

Algebraic Combinatorics has recently been energized through interactions with Probability, Mathematical Physics, and Theoretical Computer Science. Of great interest is how classical

algebro-combinatorial objects behave when their defining parameters become large or random. This new perspective has birthed the rapidly developing subject of Asymptotic Algebraic Combinatorics, the subject of this workshop. Experts in various fields will come together to build new connections and solve open problems.

This workshop included a poster session.

Comments from our participant survey:

"Great workshop! Thanks, and keep doing what you're doing."

WORKSHOP: Computational Psychiatry. FEBRUARY 18 - 21, 2020.

Organizing Committee
Tom Chou (University of California, Los Angeles)
Marti Jett (Army Futures Command, Medical Research, Fort Detrick)
John Murray (Yale University)
Virginia Pasour (U.S. Army Research Office)
Shashaank Vattikuti (National Institutes of Health (NIH))

Psychiatric disorders are typically diagnosed and evaluated using subjective psychological exams that assess symptoms, thoughts, feelings and behavioral patterns. Ongoing and recent advances in measurements provide EEG, functional MRI, optogenetic, genomic, and metabolic data. Along with mathematical methods developed to analyze these data, a more physiological and quantitative approach for diagnosis and treatment can be envisioned. This workshop will explore how modern computational tools and mathematical modeling can be integrated with measurements to improve psychiatric diagnosis and treatment.

This workshop included a poster session.

Comments from our participant survey:
"The presentations by Justin Baker and Daniel Forger were phenomenal, and addressed the key question of whether one could estimate the map between "brain states" and psychiatric dysfunction."

"Personally, I found the lectures by the handful of clinicians to be amongst the most interesting."

"The conference schedule was wonderful - very conducive to discussions with other participants"

"Computational psychiatry is likely to have a major societal impact because of its future ability to explain psychiatric dysfunction but also predict psychiatric outcomes. This is an area where the entire mathematical community (pure and applied) can contribute; it is wonderful to see IPAM be involved in this far-reaching question."

"I would like to thank the organizers for putting together the workshop. It was a big achievement! I am new to this field. It was a little overwhelming but I learned a whole lot from the speakers and the audience. I hope the organizers consider organizing something else in the future and invite me to come back to IPAM."

WORKSHOP: Intersections between Control, Learning and Optimization. FEBRUARY 24 - 28, 2020.

Organizing Committee
Moritz Diehl (University of Freiburg)
Ben Recht (University of California, Berkeley)
Stephen Wright (University of Wisconsin-Madison)
Melanie Zeilinger (ETH Zürich, University of Freiburg)

Relationships between the areas of control, learning, and optimization have always been strong, but have recently been expanding and deepening in surprising ways. Optimization formulations and algorithms have historically been vital to solving problems in control and learning, while conversely, control and learning have provided interesting perspectives on optimization methods. Intersections that have been explored recently include relationships between reinforcement learning and model predictive control, and the use of control techniques to analyze the convergence of optimization algorithms. This workshop will bring together researchers who work in Control, Learning, and Optimization to discuss current areas of interaction and explore possibilities for future areas of collaboration.

This workshop included a poster session.

This workshop is partially supported by the DOE-funded MACSER project.

Comments from our participant survey:

"This was most definitely an excellent workshop."

"It's the best workshop I have attended so far."

"It was an excellent week. There were ample time for discussions during the breaks and also good amount of Q&A during and after talks. Maybe there could be 30mins-1hour allocated for a group discussion/reflection of the ideas presented (though such group discussion sessions are a bit hard to organize/coordinate)."

LONG PROGRAM: High Dimensional Hamilton-Jacobi PDEs. MARCH 9 - JUNE 12, 2020.

Organizing Committee
Jerome Darbon (Brown University)

Craig Evans (University of California, Berkeley)
Fariba Fahroo (Air Force Office of Scientific Research (AFOSR))
Wilfrid Gangbo (University of California, Los Angeles)
Adam Oberman (McGill University)
Stanley Osher (University of California, Los Angeles)
Panagiotis Souganidis (University of Chicago)
Claire Tomlin (University of California, Berkeley)

COVID-19 Advisory: In abidance with LA Mayor Garcetti's "Safer at Home" emergency order, IPAM held all workshops that were part of "High Dimensional Hamilton-Jacobi PDEs" program online. Workshop registrants received Zoom links along with instructions a few days prior to the workshops. The video recordings of the sessions were made available on IPAM website.

Hamilton-Jacobi (HJ) Partial Differential Equations (PDEs) were originally introduced during the 19th century as an alternative way of formulating mechanics. Since then, these PDEs have received a considerable amount of attention because they arise in many scientific areas and real-life applications beyond physics. For instance, HJ PDEs appear in optimal control, stochastic optimal control, random media, probability, random dynamical systems, large deviations theory, mean field games, optimal transport, optimization in imaging sciences and machine learning.

Applications that involve HJ PDEs in a high-dimensional (and possibly infinite-dimensional) setting lead to challenging computational problems. Although a large literature is available on HJ PDEs, many challenges remain both from a mathematical and computational point of view. A lot of interactions have occurred over recent decades between these areas thanks to their connection to HJ PDEs. The subject is currently on the verge of becoming central to many new areas of applications, and progress in tackling Hamilton-Jacobi equations could lead to important advances in several fields. The main goal of this long program is to leverage synergy between different fields to advance mathematical theory and algorithms to solve real-life problems.

The program opened with one week of tutorials, presented by some of the main organizers. These tutorials provided an introduction to the major themes of the entire program and connect the themes of the four workshops. The goal was to introduce a common language and build a foundation for the participants of this program who have diverse scientific backgrounds.

During the weeks between workshops, participants were provided opportunity to develop collaborations; we expect fruitful discussions especially between domain scientists, algorithm developers and pure and applied mathematicians.

Comments from our participant survey:

"It is a great opportunity to meet people working in different fields tangent to a central area. I find IPAM/UCLA an excellent place for this."

"Everything went perfectly for the long program. It is only the unexpected COVID-19 pandemic interrupted the usual in-person meeting."

"IPAM has make all efforts for the online mode going smoothly. I really enjoy the long program. On the other hand, I still feel that online mode is not as effective as the in-person mode in terms of discussion, initiating collaboration, etc. I hope that I have another opportunity in the future to participate the IPAM program without being interrupted by any virus like COVID-19."

WORKSHOP: High Dimensional Hamilton-Jaobi PDEs Tutorials. MARCH 10 – 13, 2020.

Part of the Long Program "High Dimensional Hamilton-Jacobi PDEs"

Organizing Committee:
Jerome Darbon (Brown University)
Lawrence Evans (University of California, Berkeley (UC Berkeley), Mathematics)
Fariba Fahroo (Air Force Office of Scientific Research (AFOSR), Computational Math)
Wilfrid Gangbo (University of California, Los Angeles (UCLA))
Adam Oberman (McGill University, Mathematics and Statistics)
Stanley Osher (University of California, Los Angeles (UCLA), Mathematics)
Takis Souganidis (University of Chicago, Mathematics)
Claire Tomlin (University of California, Berkeley (UC Berkeley))

The 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.

WORKSHOP I: High Dimensional Hamilton-Jacobi Methods in Control and Differential Games. MARCH 30 - APRIL 3, 2020.

Part of the Long Program "High Dimensional Hamilton-Jacobi PDEs"

Organizing Committee
Jerome Darbon (Brown University)
Fariba Fahroo (Air Force Office of Scientific Research (AFOSR))
Stanley Osher (UCLA, Institute for Pure and Applied Mathematics (IPAM))
Claire Tomlin (University of California, Berkeley)

Solving Hamilton-Jacobi-Bellman equation is central to problems in optimal control, differential games, path planning and formal verification of reachability sets. In practical problems with nonlinear dynamics, subject to unpredictable disturbances with high-dimensional state spaces, solution of the Hamilton-Jacobi-Bellman equation becomes computationally intractable as the state space dimension increases.

As theoretical developments have advanced, computational challenges remain. For example, Hamilton-Jacobi reachability analysis is a verification method used to guarantee performance and safety properties of systems. Traditional reachable set computations involve solving an

Hamilton-Jacobi partial differential equation on a discretized state space grid, which results in an exponential scaling of computational complexity with respect to system dimensionality.

Recently proposed techniques include decomposing the computation of the reachable set into several small dimensional computations; using convex optimization applied to the Hopf-Lax formula in conditions of state and time independence, generalizations of Hopf-Lax to more complicated Hamiltonians, and applying newly developed numerical methods to convert continuous optimal control problems into nonlinear programming problems, which can then be solved using advanced nonlinear programming solvers. The choice of problem structure, conversion technique, and underlying solver makes all the difference in the quality and efficiency of the method. In particular, pseudospectral methods have proven to be extremely powerful.

Ideas to be explored in the workshop include different computational methodologies for efficient real-time solution of nonlinear HJ equations in reachability, optimal control, and differential games. Ideas such as efficient reduced-complexity computation of optimal control solutions, exploiting structure to decompose the solution space to scalable computations and reduced-complexity feedback structures for efficient implementation of optimal controllers based on available data will be considered.

This workshop focuses on how such new methods may be used to broaden the classes of control and differential game problems that may be treated.

Comments from our participant survey:

“The breakout rooms using zoom were useful.”

“Clearly the possibility to engage discussions has been limited by the on-line. Taking into account that constraint it has been EXCELLENT”

“The Zoom format makes it less social as an on-site workshop, but this is due to the Pandemic. The organizers have done a great job.”

“excellent workshop during difficult times.”

“I thank you for the organization and for the decision to run the workshop anyway despite the dfficulties. The on-line experience has been extremely good and goes beyond what I would have expected. The technicians and staff made a great job. We were missing a real coffee break but...we will wait for Zoom Bar MANY THANKS.”

WORKSHOP II: PDE and Inverse Problem Methods in Machine Learning. APRIL 20 - 24, 2020.

Part of the Long Program “High Dimensional Hamilton-Jacobi PDEs”

Organizing Committee
Adam Oberman (McGill University)
Lorenzo Rosasco (Universita' degli Studi di Genova)
Dejan Slepcev (Carnegie Mellon University)
Andrew Stuart (California Institute of Technology)
Yunan Yang (New York University)

Researchers in the areas of Partial Differential Equations and Inverse Problems have recently applied ideas from these fields to problems in Machine Learning. The areas of application include the following.

(i) Generalization: Inverse Problems approaches to Learning Theory, regularization of the loss in Deep Learning, convergence in the data sampling limit.

(ii) Optimization: PDE approaches to Stochastic Gradient Descent, Differential Equations interpretations of accelerated first order optimization methods, Convergent algorithms in Deep Learning.

(iii) Semi-supervised learning: PDEs on Graphs.

(iv) Stable architecture design using numerical stability approaches.

This workshop brought together researchers with background in PDEs, Inverse Problems, and Scientific Computing who are already working in machine learning, along with researchers who are interested in these approaches.

This workshop included a virtual poster session via Slack.

Comments from our participant survey:

“I really liked the workshop. Big thanks to the organizers and everybody involved.”

“As it was my first workshop as a PhD student, I just want to comment on this question: In my opinion you did a great organizational job making the best of it one can hope for. Of course, I suppose, one cannot achieve that small groups of people emerge, where one can connect with people one has never seen before, as in the breakout room, for example, everybody else listens. I guess this resulted therein that the discussions there were mainly led by the former speaker and the session chair(s). However, it was also nice to hear a few of their thoughts, which one might not hear when several 4-5 people groups with similar people are formed.”

WORKSHOP III: Mean Field Games and Applications. MAY 4 - 8, 2020.

Part of the Long Program “High Dimensional Hamilton-Jacobi PDEs”

Organizing Committee

Diogo Aguiar Gomes (King Abdullah Univ. of Science and Technology (KAUST))
Wilfrid Gangbo (University of California, Los Angeles)
Ryan Hynd (University of Pennsylvania)
Daniela Tonon (Université de Paris IX (Paris-Dauphine))

This week-long workshop on Mean Field Games (MFG) and Applications for has a number of goals: (i) to gather together leading researchers in MFG and certain cognate areas (economics, optimal transportation, finite dimensional Hamilton-Jacobi equations, Stochastic equations, applied control, numerics). (ii) to expose new researchers to the promise of the field and its array of challenges, while grounding them in its basic techniques; (iv) to make available to the wider community a series of broad interest talks on MFG.

This workshop included a virtual poster session via Slack.

Comments from our participant survey:

“Given the special circumstances under which the workshop was held, I thought IPAM staff did a very good job in making sure that all speakers abide by the rules and all the technology for online presentations was there, making a very smooth progression possible.”

“Very well chosen speakers, most of the talks were very interesting, which is rare for conferences in general.”

“Many thanks for your efforts to guarantee the program on-line despite the diffucult times we are living”

“The part of the series we participated in was a great success in the view of myself, my PDFs and graduate students. This follows a similar experience (but in that case "real" not "virtual") at the Mean Filed Games meeting in 2017 at IPAM. Conclusion: please continue this series of workshops.”

“Excellent workshop, innovative, looking forward to the next one. Please continue to integrate economics topics in the mean field game program.”

WORKSHOP IV: Stochastic Analysis Related to Hamilton-Jacobi PDEs. MAY 18 - 22, 2020.

Part of the Long Program “High Dimensional Hamilton-Jacobi PDEs”

Organizing Committee
Jeff Calder (University of Minnesota, Twin Cities)
Will Feldman (University of Chicago)
Grigorios Pavliotis (Imperial College)
Fraydoun Rezakhanlou (University of California, Berkeley)
Takis Souganidis (University of Chicago)

The modeling of complex multiscale phenomena often leads to problems set in random media, since periodicity is very often rather restrictive. The mathematical study then leads to stochastic homogenization and averaging. This setting however, lacks the mathematical structure and estimates available in periodic media and most, if not all, classical PDE methods fail. It becomes necessary to use sophisticated probabilistic methods to overcome difficulties.

In spite of its flexibility, computing nonlinear problems in random media is very expensive. Hence, in practice, it is needed to consider environments which are small random perturbations of periodic ones, and then to obtain some asymptotic expansion for the ergodic constants. Concrete examples of such phenomena that relate to Hamilton-Jacobi equations are large deviations, front propagation and random walks in random media. The latter strengthens the connection with probability.

Another direction where Hamilton-Jacobi connect with stochastics is the study of stochastic PDEs driven by Brownian motions or rough paths. This is an area that has seen considerable growth during the last ten years. It relates to the work on KPZ-type models as well as stochastic viscosity solutions and conservation laws. One of the striking outgrowths of these theories are new and surprising stochastic regularization-type results. A third direction is about small scale limits of deterministic and stochastic discrete models which in the limit give rise to Hamilton-Jacobi type problems. Examples are the Abelian sandpile and peeling processes. Another topic is limits of Kinetic Fokker Planck equations and degenerate elliptic operators. These types of hypoelliptic operators are fundamental models of particle interactions, which have newfound applications in optimization. We will study topics such as effective diffusivity in the Kramers to Smoluchowski limit and rates of convergence to the invariant measure in the degenerate elliptic case.

The workshop included a virtual poster session via Slack.

Comments from our participant survey:

“This was a Zoom workshop, due to social distance restrictions. Given these constraints, the workshop was very good.”

“This session was most useful for me. Please give one more workshop for improving our knowledge”
“I think the staff did a great job of setting a tone of professionalism with how they managed the administration of the workshop. The consistent structure in how lectures were set up and questions were managed projected organization and a nice academic atmosphere. I also liked how the messages used in the chat were the same everyday no matter which staff member was managing the session- it made it seem like all the staff were on the same page and set a nice model for how online workshops can be run.”

“The Zoom workshop was well done. Certainly is it not as effective as an in-person workshop, and I greatly missed being able to interact in person. Nevertheless, it was beneficial to me. Thank you, IPAM staff for making this happen despite the circumstances!”

"It is amazing how well it ran in the online format, thank you very much for the amazing effort."

WORKSHOP: Hamilton-Jacobi PDEs Culminating Workshop at Lake Arrowhead. JUNE 8 - 11, 2020.

Part of the Long Program "High Dimensional Hamilton-Jacobi PDEs"

The culminating workshop (along with the Reunion conferences) could not be held at Lake Arrowhead as per tradition due to COVID-19 pandemic. Instead, a 3-day workshop was held over zoom which was quite successful.

REUNION CONFERENCE: Big Data Meets Large-Scale Computing Reunion Conference I. JUNE 7 – 12, 2020.

The Reunion conference was postponed due to the COVID-19 pandemic. We plan to arrange the event at a later time.

REUNION CONFERENCE: Complex High-Dimensional Energy Landscapes Reunion Conference II. JUNE 7 – 12, 2020.

The Reunion conference was postponed due to the COVID-19 pandemic. We plan to arrange the event at a later time.

OUTREACH ACTIVITIES, 2019-2020

IPAM supports the UCLA chapter of Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS): Our Associate Director and Outreach Coordinator attend quarterly meetings and encourages SACNAS members to participate in IPAM programs. The chapter used IPAM facilities for a K-12 educational event, an undergraduate research symposium for community college students, and occasional other meetings and study sessions.

In the past year, IPAM representatives attended national diversity conferences to promote math programs to underrepresented groups. The Associate Director and Assistant Director attended the 2019 Modern Math Workshop and SACNAS National Conference to advertise upcoming opportunities and to network with faculty and students. IPAM shared a booth at the 2019 SACNAS National Conference with four other math institutes (MSRI, ICERM, SAMSI, and AIM).

In September 2019, IPAM was at NAM's Undergraduate MATHFest held in New Orleans, which encourages students to pursue advanced degrees in math and math education.

Over 30 RIPS and GRIPS students from the 2019 cohorts made poster and oral presentations on their summer research projects at the 2020 Joint Mathematics Meetings (JMM) held in Denver, Colorado, in January 2020. At the MAA Undergraduate Poster Session, six teams representing IPAM and their respective sponsors were honored with the "Outstanding Award": Alibaba, AMD, Google-LA, GumGum, HRL, and LLNL. Four more teams were chosen for "Honorable Mention": Aerospace, GRAB, Google-Singapore, and NVIDIA.

In February 2020, four former RIPS students attended and shared personal research from their summer at IPAM at the Nebraska Conference for Undergraduate Women in Math (NCUWM) to promote the RIPS 2020 summer program and to talk to undergraduate women about opportunities in math. On behalf of their RIPS teams, Andrea Boskovic represented Team Alibaba, Parmida Davarmanesh represented Team AMD, Amber Hu represented Team GumGum, and Katherine Thai represented Team Aerospace. IPAM paid for their travel.

IPAM presented Berland Foundation awards to one participant with a family in the past year. The funds helped pay for child care, housing, or other expenses necessary to allow them to fully participate in the workshop or long program.

Finally, IPAM advertised its RIPS (undergraduate) and GRIPS (graduate) programs through minority institutions and organizations.

K. PROGRAM CONSULTANT LIST

IPAM consulted a variety of scholars and practitioners in the scientific planning of its programs. The list below includes program organizers for the programs that took place during this reporting period or upcoming programs for which organizing committees have begun meeting. The list excludes IPAM's scientific staff (directors) and members of IPAM's Science Advisory Board and Board of Trustees, who are listed in "Section O, Committee Membership". On occasion, IPAM scientific staff and Board Members are organizers of workshops and long programs, and are therefore included in the list below.

Full Name	Institution
Diogo Aguiar Gomes	King Abdullah Univ. of Science and Technology (KAUST)
Pilar Ariza	University of Sevilla
Alán Aspuru-Guzik	University of Toronto

Andrea Bertozzi	University of California, Los Angeles (UCLA)
Joan Bruna	New York University
Steve Brunton	University of Washington
Jeff Calder	University of Minnesota, Twin Cities
Eric Cances	École Nationale des Ponts-et-Chaussées
Tom Chou	UCLA, Cambridge
Cecilia Clementi	Rice University
Kyle Cranmer	New York University
Jerome Darbon	Brown University
Moritz Diehl	University of Freiburg
Maria D'Orsogna	Institute for Pure and Applied Mathematics
Lawrence Evans	University of California, Berkeley (UC Berkeley)
Fariba Fahroo	Air Force Office of Scientific Research (AFOSR)
Will Feldman	IAS and Univ. of Utah
Jacob Foster	University of California, Los Angeles (UCLA)
Wilfrid Gangbo	University of California, Los Angeles (UCLA)
Ben Glocker	Imperial College
Mark Green	University of California, Los Angeles (UCLA)
Ryan Hynd	University of Pennsylvania
Jonathan Jacobs	University of California, Los Angeles (UCLA)
Marti Jett	Army Futures Command, Medical Research, Fort Detrick
Eurika Kaiser	University of Washington
Efthimios (Tim) Kaxiras	Harvard University
Gitta Kutyniok	Technische Universität Berlin
J. Nathan Kutz	University of Washington
Yann LeCun	New York University
Mitchell Luskin	University of Minnesota, Twin Cities
Dionisios Margetis	University of Maryland
Noa Marom	Carnegie Mellon University
Emeran Mayer	University of California, Los Angeles (UCLA)
Marina Meila	University of Washington
Joel Miller	La Trobe University
Jeff Miller	University of California, Los Angeles (UCLA)
John Murray	Yale University
Marc Niethammer	University of North Carolina
Frank Noe	Freie Universität Berlin
Jonathan Novak	University of California, San Diego (UCSD)
Adam Oberman	McGill University
Stanley Osher	University of California, Los Angeles (UCLA)
Aydogan Ozcan	University of California, Los Angeles (UCLA)
Francesco Paesani	University of California, San Diego (UCSD)
Igor Pak	University of California, Los Angeles (UCLA)
Greta Panova	University of Southern California (USC)
Virginia Pasour	U.S. Army Research Office, UNC-Chapel Hill
Ankit Patel	Rice University
Grigorios Pavliotis	Imperial College

Mason A. Porter	University of California, Los Angeles (UCLA)
Ben Recht	University of California, Berkeley (UC Berkeley)
Fraydoun Rezakhanlou	University of California, Berkeley (UC Berkeley)
Lorenzo Rosasco	Università di Genova
Daniel Rueckert	Imperial College
Matthias Rupp	Citrine Informatics & Fritz-Haber-Institut der Max-Planck-Gesellschaft
Katya Scheinberg	Cornell University
David Schriger	University of California, Los Angeles (UCLA)
Christof Schuette	Freie Universität Berlin
Jin Keun Seo	Yonsei University
Dejan Slepcev	Carnegie Mellon University
Alicia Solow-Niederman	Independent Researcher
Panagiotis Souganidis	University of Chicago
Andrew Stuart	California Institute of Technology
Claire Tomlin	University of California, Berkeley (UC Berkeley)
Daniela Tonon	Université de Paris IX (Paris-Dauphine)
Michael Unser	École Polytechnique Fédérale de Lausanne (EPFL)
Ruth Urner	York University
Shashaank Vattikuti	National Institutes of Health (NIH)
Michael Weinstein	Columbia University
Paul Weiss	University of California, Los Angeles (UCLA)
Andrew White	University of Rochester
Stephen Wright	University of Wisconsin-Madison
Yunan Yang	New York University
Jong Chul Ye	Korea Advanced Institute of Science and Technology (KAIST)
Lenka Zdeborová	Commissariat à l'Énergie Atomique (CEA)
Riccardo Zecchina	Bocconi University
Melanie Zeilinger	ETH Zurich

L. PUBLICATIONS LIST

This report includes publications that resulted from the fall 2017 long program, as well as the publications of our Director, Deputy Director, Associate Director, and Director of Special Projects from the past year. We asked the participants of Complex High-Dimensional Energy Landscapes (fall 2017) to list their publications that were a result of or significantly influenced by the IPAM program as both groups completed their second reunion conferences during this reporting period. These publications were entered into the project reports “products” form in Research.gov. We chose not to include pre-prints. We confirmed that the publications in this report were not reported in our previous annual reports.

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)-Los Angeles. Companies and other organizations sponsor research projects and one or more representatives of the organization interact with the student team. Many of them are listed as participants of RIPS-LA and RIPS-LA Projects Day.

IPAM received some grants and gifts during this period from government and military agencies to support specific programs, including:

- IRES grant through NSF-OISE supports GRIPS-Berlin (9/1/2018-8/31/2021; $233,235)
- NSF Mathematical Sciences Institutes Diversity Initiative – Latinx in the Mathematical Sciences (9/15/19-8/31/22; $117,130)
- Research in Industrial Projects for Students (RIPS) collects sponsorship fees from its corporate and other sponsors, which cover some of the program expenses
    - Livermore National Lab: RIPS2019; $25,000
    - Air Force Research Laboratory: RIPS2019; $25,000

We seek the advice of government and industry by recruiting corporate and government leaders to serve on our Science Advisory Board and Board of Trustees. See section O for a complete list of members and their affiliations.

Out of all of IPAM's participants during this reporting period, 36 held positions in government or military organizations, such as Los Alamos, Argonne, Lawrence Berkeley, Fermi National Accelerator Laboratory, Lawrence Livermore, NASA - Ames Research Center, and Oak Ridge National Labs. Five of our workshop speakers came from government or military labs.

Participants also included industry representatives, such as Google, AMD, IBM, Microsoft Research, Amazon, Alibaba, Walt Disney Animation Studios, Memorial Sloan-Kettering Cancer Center, JPMorgan Chase, and more. Sixteen workshop speakers were from the industry and private sector.

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. The table shows other funding received by IPAM from June 1, 2019 through May 31, 2020.

Table N: Other Funding Support	
Federal Funding	
NSF MSIDI Latinx in the Mathematical Sciences	$117,130
NSF-IRES Track 1 - GRIPS Berlin	$76,900
Sub-total	$194,030
Support from Foundations and Endowments	
UC Regents Matching - IPAM's Director Endowment	$100,000
Simon's Foundation	$192,985
IPAM Director's Endowment Fund	$132,500
Sub-total	$425,485
UCLA Funding	
Dean Physical Sciences	$130,902
Vice Chancellor for Research	$141,157
Sub-total	$272,059
Industrial Affiliates and Other Support	
Aerospace Corporation - 2020	$28,000
Alibaba Group – 2019	$25,000
Air Force Research Laboratory - 2019	$25,000
Aquatic - 2020	$20,000
Google – 2020	$28,000
Lawrence Livermore National Laboratory - 2019	$25,000
Microsoft - 2019	$10,000
Sub-total	$161,000
Others	
Other Donors	$16,960
TOTAL	$1,069,534

O. COMMITTEE MEMBERSHIP

IPAM's committees include the Board of Trustees and Science Advisory Board. The members during the reporting period are listed below. The IPAM directors are *ex officio* members.

Board of Trustees, 2019-2020 Membership

Name	Institution	Department or title
David Balaban	Amgen	Scientist
Katy Börner	Indiana Uni., Bloomington	Distinguished Professor of Engineering and Information Science
Russel Caflisch	New York University	Director, Courant Institute
Tony Chan	KAUST	President
Brenda Dietrich	Cornell University	Professor
Karina Edmonds	Google	Google Cloud University Relations Lead
Katherine Ensor	Rice Univeristy	Noah G. Harding Professor of Statistics
James Gidney	The Aerospace Corporation	Director, Navigation and Geopositioning Systems Department
Mark Green	UCLA	Mathematics
Alfred Hales	CCR West	
Sallie Keller	Virginia Tech University	Professor of Statistics, Director
Steven Koonin	New York University	
Alan Lee	AMD Research	Corporate Vice President of Engineering Research
Monique Miller	Wilshire Funds Management	Managing Director
Nancy Potok	US Government	Chief Statistician
Ronald Stern	UC Irvine	
Tatiana Toro	University of Washington	Mathematics
Leland Wilkinson	H2O.ai	Chief Scientist
Jeannette Wing	Columbia University	Director, Data Science Institute

Science Advisory Board, 2019-2020 Membership

Name	Institution	Discipline or department
Alexei Borodin	MIT	Mathematics
Michael Brenner	Harvard	School of Engineering and Applied Sciences
Emery Brown	MIT	Professor of Medical Engineering and of Computational Neuroscience
Robert Calderbank	Duke University	Director of the Information Initiative
Emmanuel Candes	Stanford University	Professor of Mathematics and of Statistics
Cecilia Clemente	Rice	Chemistry
Cynthia Dwork	Harvard University, SEAS	Gordon McKay Prof. of Computer Science
Jordan Ellenberg	Univ of Wisconsin	Mathematics

Peter Wilcox Jones	Yale University	Mathematics
Yann LeCun	New York Uni./Facebook	Computer Science
David Levermore	University of Maryland	Applied Math
Xihong Lin	Harvard	T H Chan School of Public Health
Robert Klaus-Mueller	TU Berlin	Machine Learning Group
Assaf Naor	Princeton	Mathematics
Pablo Parrilo	MIT	Electrical Engineering and Computer Science
Terence Tao	UCLA	Mathematics
Luca Trevisan	UC Berkeley	Electrical Engineering and Computer Science
Amie Wilkinson	Univ. of Chicago	Mathematics