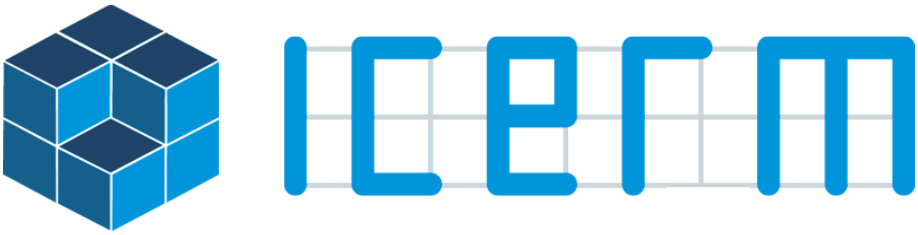

Institute for Computational and Experimental Research in Mathematics

Annual Report
May 1, 2018 – May 10, 2019

Brendan Hassett, Director
Mathew Borton, IT Director
Jeff Brock, Associate Director (through June 30, 2018)
Ruth Crane, Assistant Director
Sigal Gottlieb, Deputy Director
Elisenda Grigsby, Deputy Director
Jeffrey Hoffstein, Consulting Associate Director
Caroline Klivans, Associate Director
Jill Pipher, Consulting Associate Director
Bjorn Sandstede, Associate Director
Homer Walker, Consulting Associate Director
Ulrica Wilson, Associate Director for Diversity and Outreach

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Mission

The mission of the Institute for Computational and Experimental Research in Mathematics (ICERM) is to support and broaden the relationship between mathematics and computation: specifically, to expand the use of computational and experimental methods in mathematics, support theoretical advances related to computation, and address problems posed by the existence and use of the computer through mathematical tools, research and innovation.

Core Programs and Events

Note: To ensure we report the most accurate data and to better reflect ICERM's natural programmatic starting and end dates, the 2018-2019 report will include all program details between May 1, 2018 and May 10, 2019. The May 10th end date allows us to include all the data through to the last day of our spring 2019 semester program.

ICERM's scheduled programs and events from May 1, 2018 through May 10, 2019

TYPE	TITLE	START	END	# Participants
Topical Workshop	Birational Geometry and Arithmetic	14-May-18	18-May-18	73
Topical Workshop	Frame Theory and Exponential Bases	4-Jun-18	8-Jun-18	40
Summer@ICERM	Summer@ICERM 2018: Low Dimensional Topology and Geometry	11-Jun-18	3-Aug-18	29
Collaborate@ICERM	Adaptive Multilevel Monte Carlo Finite Element Methods: Overcoming Complex Physics in Subsurface Flow through Efficient Computing	11-Jun-18	15-Jun-18	3
Topical Workshop	Fractional PDEs: Theory, Algorithms and Applications	18-Jun-18	22-Jun-18	80
Topical Workshop	Computational Aspects of Time Dependent Electromagnetic Wave Problems in Complex Materials	25-Jun-18	29-Jun-18	58
Collaborate@ICERM	Unipotent elements of the symmetric spaces of SL3(k) and SL4(k)	16-Jul-18	20-Jul-18	6
Collaborate@ICERM	High Order Semi-implicit IMEX WENO Schemes for Isentropic Euler System with All-Mach Number	23-Jul-18	27-Jul-18	4
Topical Workshop	SageDays@ICERM: Combinatorics and Representation Theory	23-Jul-18	27-Jul-18	68
Collaborate@ICERM	Circle Packings and Geometric Rigidity	6-Aug-18	10-Aug-18	6
Collaborate@ICERM	Control and Analysis of Large-Scale Time-Varying Data	6-Aug-18	10-Aug-18	7
TRIPODS	TRIPODS Summer Bootcamp: Topology and Machine Learning	6-Aug-18	10-Aug-18	36
GirlsGetMath	GirlsGetMath@ICERM: Summer Math Camp for High School Girls	6-Aug-18	10-Aug-18	34
TRIPODS	Building Community in the Foundations of Data Science	13-Aug-18	14-Aug-18	23

Research Experiences for Undergraduate Faculty (REUF)	REUF Continuation Group: DNA Self-Assembly	13-Aug-18	17-Aug-18	5
Research Experiences for Undergraduate Faculty (REUF)	REUF Continuation Group: Arithmetical Structures on Graphs	13-Aug-18	17-Aug-18	6
Collaborate@ICERM	Asymptotic Topology of the Perceptron Model	13-Aug-18	17-Aug-18	3
Collaborate@ICERM	Mean Reeb Graphs	20-Aug-18	24-Aug-18	6
Topical Workshop	Advances in PDEs: Theory, Computation and Application to CFD	20-Aug-18	24-Aug-18	101
Semester Workshop	Nonlinear Algebra Bootcamp	5-Sep-18	12-Sep-18	55
Semester Program	Nonlinear Algebra	5-Sep-18	7-Dec-18	97
Semester Workshop	Core Computational Methods	17-Sep-18	21-Sep-18	83
Public Lecture	An ICERM Public Lecture: How to be Human in the Age of Algorithms, featuring Dr. Hannah Fry	27-Sep-18	27-Sep-18	285
Semester Workshop	Real Algebraic Geometry and Optimization	15-Oct-18	19-Oct-18	126
Topical Workshop	Celebrating 75 Years of Mathematics of Computation	1-Nov-18	3-Nov-18	136
Public Lecture	Mathematics: Rhyme and Reason, featuring Dr. Mel Curie	8-Nov-18	8-Nov-18	91
Special Event (MSIDI)	Blackwell-Tapia Conference 2018	9-Nov-18	10-Nov-18	119
Semester Workshop	Nonlinear Algebra in Applications	12-Nov-18	16-Nov-18	104
Collaborate@ICERM	Topological Data Analysis and Music Information Retrieval	7-Jan-19	11-Jan-19	4
TRIPODS	Models and Machine Learning for Causal Inference and Decision Making in Health Research	14-Jan-19	18-Jan-19	62
Hot Topics Workshop	Scientific Machine Learning (funded by Simons Foundation)	28-Jan-19	30-Jan-19	145
Research Cluster	Algebraic Vision Research Cluster (funded by Simons Foundation)	28-Jan-19	15-Feb-19	16
Simons Collaboration	Abelian varieties over finite fields	31-Jan-19	3-Feb-19	11
Collaborate@ICERM	A Broken Circuit Model for Chromatic Symmetric Homology	4-Feb-19	4-Feb-19	4
Semester Program	Computer Vision	4-Feb-19	10-May-19	51
Semester Workshop	Theory and Practice in Machine Learning and Computer Vision	18-Feb-19	22-Feb-19	110
Public Lecture	Discovering Black Holes and Gravitational Waves: Algorithms and Simulation, featuring Dr. Scott Field	20-Feb-19	20-Feb-19	130
Semester Workshop	Image Description for Consumer and Overhead Imagery	25-Feb-19	26-Mar-19	37

Hot Topics Workshop	Modularity and 3-manifolds (funded by Simons Foundation)	8-Mar-19	10-Mar-19	28
Public Lecture	Bias in Bios: Fairness in a High-stakes Machine-learning Setting, featuring Dr. Adam Tauman Kalai	8-Mar-19	10-Mar-19	124
Semester Workshop	Computational Imaging	18-Mar-19	22-Mar-19	89
Semester Workshop	Optimization Methods in Computer Vision and Image Processing	29-Apr-19	3-May-19	63
Public Lecture	What's the big deal about calculus?, featuring Dr. Steven Strogatz	8-May-19	8-May-19	150
Semester Workshop	Introduction to the ANTs Ecosystem	10-May-19	10-May-19	12

Note: The Simons Collaboration and GirlsGetMath@ICERM programs are not funded through ICERM's core grant. REUF is supported by the National Science Foundation through a DMS grant to ICERM. Brown University's Data Science Initiative partners with ICERM on public events, included workshops supported by the TRIPODS grant from the National Science Foundation.

Participant Summaries by Program Type

The tables below display breakdowns of ICERM's confirmed participants by category during the reporting period for all funded programs. Each participant is represented once per unique visit regardless of the number of programs they attended during a visit.

ICERM Funded Participants

	Program Type	Summer@ICERM 2018	9 Collaboration Groups	Blackwell-Tapia	TRIPODS 1	TRIPODS 2	TRIPODS 3	Fall Semester '18						Spring Semester '19								Topical '18 - '19							
								Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Research Cluster 1	% of # Reporting	Workshop A	Workshop B	Workshop C	Workshop D	Workshop E	Workshop F	Workshop G	% of # Reporting
Gender and Ethnicity	Total Participants	28	43	82	29	11	22	95	29	49	68	68		37	55	12	54	53	2	2		45	35	53	47	51	77	100	
	Female	12	21	26	12	3	2	30	10	12	23	23	34%	10	15	2	15	16	0	2	34%	7	8	8	12	11	17	28	28%
	Other	1	0	0	0	0	0	1	0	0	0	0	0.3%	0	0	0	0	0	0	0	0%	0	0	0	1	0	0	0	0%
	# Reporting Gender	26	37	76	26	5	6	92	28	46	63	63		33	46	8	45	45	0	2		33	28	45	36	36	64	88	
	African American	1	1	33	0	0	1	0	0	0	0	0	0%	0	0	0	0	1	0	0	1%	0	0	2	1	0	1	0	0.3%
	American Indian	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1%	0	0	0	0	0	0	0	0%
	Asian	10	6	8	5	0	2	12	5	6	7	7	14%	6	14	2	20	18	0	0	35%	12	5	21	16	11	39	32	50%
	Hispanic	3	1	25	0	0	1	5	1	4	8	8	10%	5	0	0	3	4	0	0	7%	2	0	1	0	0	3	4	4%
	# Reporting Ethnicity	24	32	79	26	3	7	79	25	39	57	57		31	46	8	47	42	0	2		31	25	28	25	25	61	76	
Geographical Point of Origin	US - Midwest	2	4	14	6	0	1	11	1	3	4	4	7%	5	5	0	6	5	0	0	10%	5	3	14	8	13	19	19	19%
	US - Northeast	18	6	21	7	11	17	6	4	3	6	6	8%	9	16	4	16	12	1	1	27%	12	7	8	12	10	18	31	24%
	US - South	3	10	28	4	0	2	18	7	13	15	15	22%	8	16	1	12	8	1		21%	6	9	10	7	2	15	25	18%
	US - West	4	5	14	9	0	2	13	3	8	12	12	16%	1	6	3	8	7	0	0	12%	5	4	6	9	8	8	6	11%
	Africa	0	0	1	0	0	0	0	0	0	1	1	1%	0	0	0	1	0	0	0	0.5%	0	0	0	0	0	0	0	0%
	Asia	0	0	1	0	0	0	6	2	2	1	1	4%	5	7	2	2	6	0	0	10%	4	4	8	1	6	10	3	9%
	Canada	0	0	0	0	0	0	0	0	0	0	0	0%	2	3	0	2	2	0	0	4%	10	8	6	8	7	7	15	15%
	Europe	0	8	3	2	0	0	39	12	20	29	29	42%	4	2	1	7	8	0	1	11%	10	8	6	8	7	7	15	15%
	Latin & South America	1	0	0	1	0	0	2	0	0	0	0	1%	3	0	0	0	5	0	0	4%	1	0	0	0	0	0	1	0.5%
	Oceania	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	1	0	0	0	0	0.5%	0	0		0	0	0	1	0.2%

All Participants (ICERM funded and Non-ICERM funded)

	Program Type	Summer@ICERM 2018	9 Collaboration Groups	Blackwell-Tapia	TRIPODS 1	TRIPODS 2	TRIPODS 3	Fall Semester '18						Spring Semester '19								Topical '18 - '19							
								Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Research Cluster 1	% of # Reporting	Workshop A	Workshop B	Workshop C	Workshop D	Workshop E	Workshop F	Workshop G	% of # Reporting
	Total Participants	29	43	113	36	22	62	97	30	51	92	77		51	79	7	63	63	6	4		73	38	80	58	68	101	133	
Gender and Ethnicity	Female	12	21	37	14	4	15	31	11	12	25	24	32%	12	19	2	18	17	3	2	32%	15	9	15	16	15	23	35	28%
	Other	1	0	0	0	0	0	1	0	0	0	0	0.3%	0	0	0	0	0	0	0	0%	0	0	0	1	0	0	0	0.2%
	# Reporting Gender	27	37	105	33	11	36	94	29	48	83	71		46	63	10	52	54	4	2		58	31	65	46	52	83	115	
	African American	1	1	46	0	0	1	0	0	0	0	0	0%	0	0	0	1	2	0	0	1%	0	1	2	1	1	1	1	2%
	American Indian	0	0	3	0	0	0	0	0	0	0	0	0%	0	0	0	0	1	0	0	0.5%	0	0	0	0	0	0	0	0%
	Asian	11	6	10	6	0	10	13	5	6	22	8	19%	9	21	3	24	20	1	0	36%	22	5	29	22	16	46	48	49%
	Hispanic	3	1	30	1	0	2	5	1	4	4	8	8%	7	1	2	3	4	0	0	8%	3	0	1	0	1	4	5	4%
	# Reporting Ethnicity	25	32	109	34	7	35	80	26	40	74	64		46	61	11	48	49	3	2		55	27	45	33	42	76	103	
Geographical Point of Origin	US Based	28	35	107	33	22	61	49	16	28	51	45	54%	35	65	13	49	40	5	3	74%	52	26	60	42	48	82	107	76%
	Foreign Based	1	8	6	3	0	1	48	14	23	41	32	46%	16	14	4	14	23	1	1	26%	21	12	20	16	20	19	26	24%

ICERM Funded Speakers

	Program Type	Summer@ICERM 2018	9 Collaboration Groups	Blackwell-Tapia	TRIPODS 1	TRIPODS 2	TRIPODS 3	Fall Semester '18						Spring Semester '19								Topical '18 - '19							
								Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Research Cluster 1	% of # Reporting	Workshop A	Workshop B	Workshop C	Workshop D	Workshop E	Workshop F	Workshop G	% of # Reporting
Gender and Ethnicity	Total Participants	1	0	11	10	10	19	0	4	15	20	17		0	17	7	17	16	0	0		17	23	23	27	20	19	8	
	Female	0	0	4	4	3	2	0	0	2	3	8	31%	0	3	1	2	6	0	0	41%	1	5	3	2	5	3	2	26%
	Other	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	1	0	0	0	1%
	# Reporting Gender	1	0	9	7	4	4	0	3	12	14	13		0	9	3	8	9	0	0		8	14	17	16	7	8	9	
	African American	0	0	3	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	American Indian	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	1	0	0	4%	0	0	0	0	0	0	0	0%
	Asian	0	0	0	2	0	1	0	0	1	1	1	9%	0	2	0	1	1	0	0	15%	1	2	1	5	4	0	1	30%
	Hispanic	0	0	5	0	0	0	0	1	2	2	2	21%	0	0	0	1	0	0	0	4%	0	0	1	0	0	0	0	2%
	# Reporting Ethnicity	0	0	12	7	3	4	0	3	8	11	11		0	10	3	7	6	0	0		5	13	2	9	5	8	5	
Geographical Point of Origin	US - Midwest	0	0	1	3	0	1	0	0	1	1	1	5%	0	3	0	2	0	0	0	9%	2	1	6	6	3	2	4	16%
	US - Northeast	1	0	5	5	10	14	0	2	2	4	2	18%	0	7	3	8	4	0	0	39%	6	3	2	5	5	3	5	20%
	US - South	0	0	3	1	0	2	0	1	2	2	3	11%	0	1	1	2	1	0	0	9%	1	6	4	3	2	4	1	14%
	US - West	0	0	1	1	0	2	0	0	5	3	3	20%	0	2	3	1	2	0	0	14%	2	2	3	5	4	2	1	13%
	Africa	0	0	1	0	0	0	0	0	0	0	1	2%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	Asia	0	0	0	0	0	0	0	0	0	0	0	0%	0	3	0	0	1	0	0	7%	2	4	2	0	2	5	0	10%
	Canada	0	0	0	0	0	0	0	0	0	1	0	2%	0	1	0	1	2	0	0	7%	0	0	0	2	2	0	2	4%
	Europe	0	0	0	0	0	0	0	1	5	9	7	39%	0	0	0	3	6	0	0	16%	4	7	6	6	2	3	4	22%
	Latin & South America	0	0	0	0	0	0	0	0	0	1	0	2%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	Oceania	0	0	0	0	0	0	0	0	0	1	0	2%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	1	1%

All Speakers (ICERM funded and Non-ICERM funded)

	Program Type	Summer@ICERM 2018	9 Collaboration Groups	Blackwell-Tapia	TRIPODS 1	TRIPODS 2	TRIPODS 3	Fall Semester '18						Spring Semester '19								Topical '18 - '19							
								Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Research Cluster 1	% of # Reporting	Workshop A	Workshop B	Workshop C	Workshop D	Workshop E	Workshop F	Workshop G	% of # Reporting
Gender and Ethnicity	Total Participants	1	0	11	10	10	24	0	4	15	20	18		0	18	7	20	17	0	0		19	23	24	27	20	25	19	
	Female	0	0	4	4	3	3	0	0	2	3	8	30%	0	3	1	2	6	0	0	38%	1	5	3	2	5	4	2	24%
	Other	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	1	0	0	0	1%
	# Reporting Gender	1	0	9	7	4	8	0	3	12	14	14		0	9	3	10	10	0	0		10	17	18	16	7	13	10	
	African American	0	0	3	0	0	0	0	0	0	0	0	0%	0	0	0	1	0	0	0	4%	0	0	0	0	0	0	0	0%
	American Indian	0	0	3	0	0	0	0	0	0	0	0	0%	0	0	0	0	1	0	0	4%	0	0	0	0	0	0	0	0%
	Asian	0	0	0	2	0	1	0	0	1	1	1	9%	0	2	0	1	1	0	0	14%	1	2	1	5	4	1	2	29%
	Hispanic	0	0	5	0	0	0	0	1	2	2	2	21%	0	0	0	1	0	0	0	4%	0	0	1	0	0	1	0	4%
	# Reporting Ethnicity	0	0	12	7	3	8	0	3	8	11	12		0	10	3	8	7	0	0		7	13	2	9	5	13	6	
Geographical Point of Origin	US Based	1	0	10	10	10	24	0	3	10	8	10	54%	0	13	7	14	8	0	0	68%	13	12	16	18	14	17	12	65%
	Foreign Based	0	0	1	0	0	0	0	1	5	12	8	46%	0	5	0	6	9	0	0	32%	6	11	8	9	6	8	7	35%

ICERM Funded Postdocs

	Program Type	Summer@ICERM 2018	9 Collaboration Groups	Blackwell-Tapia	TRIPODS 1	TRIPODS 2	TRIPODS 3	Fall Semester '18						Spring Semester '19								Topical '18 - '19							
								Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Research Cluster 1	% of # Reporting	Workshop A	Workshop B	Workshop C	Workshop D	Workshop E	Workshop F	Workshop G	% of # Reporting
Gender and Ethnicity	Total Participants	1	6	8	3	1	3	20	7	10	15	15		8	8	2	9	8	0	1		13	5	4	2	11	11	11	
	Female	0	4	2	1	1	2	8	4	4	5	5	41%	3	1	0	3	1	0	1	24%	4	0	1	0	3	2	3	24%
	Other	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	# Reporting Gender	1	6	8	3	1	2	20	7	9	15	13		8	8	2	9	8	0	1		11	5	4	1	10	11	11	
	African American	0	0	1	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	American Indian	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	Asian	0	2	0	0	0	1	5	2	2	5	2	30%	3	2	0	6	4	0	0	43%	3	2	1	1	3	8	6	55%
	Hispanic	0	1	6	0	0	0	4	1	2	1	2	19%	2	0	0	0	0	0	0	6%	0	0	1	0	0	1	1	7%
	# Reporting Ethnicity	0	5	8	3	1	2	17	6	7	14	10		7	8	2	9	8	0	1		11	5	2	1	7	9	9	
Geographical Point of Origin	US - Midwest	0	0	2	0	0	0	3	0	1	1	1	9%	1	0	0	1	0	0	0	6%	1	0	2	0	3	1	2	16%
	US - Northeast	1	4	2	2	1	3	2	1	1	4	2	15%	3	2	0	2	4	0	0	31%	2	1	1	1	2	5	4	28%
	US - South	0	0	0	0	0	0	2	0	0	1	0	4%	2	2	0	1	2	0	0	19%	2	2	1	0	0	1	3	16%
	US - West	0	1	4	1	0	0	3	2	2	3	2	18%	1		1	3	0	0	0	19%	1	1	0	1	1	1	0	9%
	Africa	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	Asia	0	0	0	0	0	0	1	1	1	1	1	7%	0	1	0	0	1	0	0	6%	0	0	0	0	2	2	1	9%
	Canada	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	2	0	0	0	2	0	0	7%
	Europe	0	1	0	0	0	0	9	3	5	5	9	46%	1	1	1	2	1	0	1	19%	5	1	0	0	1	1	1	16%
	Latin & South America	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	Oceania	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%

All Postdocs (ICERM funded and Non-ICERM funded)

	Program Type	Summer@ICERM 2018	9 Collaboration Groups	Blackwell-Tapia	TRIPODS 1	TRIPODS 2	TRIPODS 3	Fall Semester '18						Spring Semester '19								Topical '18 - '19							
								Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Research Cluster 1	% of # Reporting	Workshop A	Workshop B	Workshop C	Workshop D	Workshop E	Workshop F	Workshop G	% of # Reporting
Gender and Ethnicity	Total Participants	1	6	8	3	3	5	20	7	10	18	18		10	10	2	9	9	0	1		14	5	10	7	13	12	14	
	Female	0	4	2	1	2	2	8	4	4	6	5	39%	3	1	0	3	1	0	1	22%	4	0	3	1	5	2	3	26%
	Other	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	# Reporting Gender	1	6	8	3	2	4	20	7	9	18	15		10	10	2	9	9	0	1		12	5	9	5	12	12	13	
	African American	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	1	2%
	American Indian	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	Asian	0	2	0	0	0	2	5	2	2	7	2	31%	3	2	0	6	5	0	0	40%	3	2	4	3	5	8	7	55%
	Hispanic	0	1	6	0	0	0	4	1	2	1	2	17%	2	0	0	0	0	0	0	5%	0	0	1	0	0	1	1	5%
	# Reporting Ethnicity	0	5	8	3	2	4	17	6	7	17	11		9	10	2	9	9	0	1		12	5	7	4	9	9	12	
Geographical Point of Origin	US Based	1	5	8	3	3	5	10	3	4	10	8	48%	8	8	1	7	7	0	0	76%	7	4	9	6	7	9	11	71%
	Foreign Based	0	1	0	0	0	0	10	4	6	8	10	52%	2	2	1	2	2	0	1	24%	7	1	1	1	6	3	3	29%

ICERM Funded Graduate Students

	Program Type	Summer@ICERM 2018	9 Collaboration Groups	Blackwell-Tapia	TRIPODS 1	TRIPODS 2	TRIPODS 3	Fall Semester '18						Spring Semester '19								Topical '18 - '19							
								Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Research Cluster 1	% of # Reporting	Workshop A	Workshop B	Workshop C	Workshop D	Workshop E	Workshop F	Workshop G	% of # Reporting
Gender and Ethnicity	Total Participants	5	6	21	12	0	0	20	3	19	21	20	%	8	19	2	6	11	0	1		6	6	12	9	15	24	17	
	Female	2	4	7	6	0	0	9	6	7	9	8	42%	3	8	0	3	3	0	1	32%	1	2	1	2	3	9	7	29%
	Other	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	# Reporting Gender	4	6	21	12	0	0	20	13	19	1	20		8	19	1	16	11	0	1		6	5	12	9	14	24	16	
	African American	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	1	1	0	0	0	2%
	American Indian	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	Asian	2	2	2	4	0	0	3	3	3	8	5	24%	2	7	0	4	5	0	0	33%	4	2	9	5	4	17	9	57%
	Hispanic	0	0	9	0	0	0	1	0	0	1	2	4%	1	0	0	0	1	0	0	4%	1	0	0	0	0	1	0	2%
	# Reporting Ethnicity	3	6	22	12	0	0	20	12	17	21	20		9	20	1	12	11	0	1		6	6	13	8	12	25	17	
Geographical Point of Origin	US - Midwest	2	1	3		0	0	2	1	1	1	1	6%	1	1	0	0	1	0	0	5%	1	1	5	2	5	11	2	30%
	US - Northeast	3	3	2	1	0	0	0	0	0	1	0	1%	2	5	1	4	1	0	1	25%	3	3	4	2	1	3	5	24%
	US - South	0	1	9	1	0	0	8	5	8	8	6	38%	2	10	0	6	2	0	0	35%	0	1	0	0	0	5	3	10%
	US - West	0	1	4	5	0	0	3	1	2	5	4	16%	0	1	0	1	3	0	0	9%	1	0	2	2	3	3	3	16%
	Africa	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	1	0	0	0	2%	0	0	0	0	0	0	0	0%
	Asia	0	0	1	0	0	0	1	1	1	1	1	5%	1		1	0	2	0	0	11%	0	1	0	0	2	1	1	6%
	Canada	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	1	0	2	0	0	3%
	Europe	0	0	2	2	0	0	6	5	7		8	33%	2	0	0	4	1	0	0	12%	1	0	0	3	2	1	3	11%
	Latin & South America	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	1	0	0	2%	0	0	0	0	0	0	0	0%
	Oceania	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%

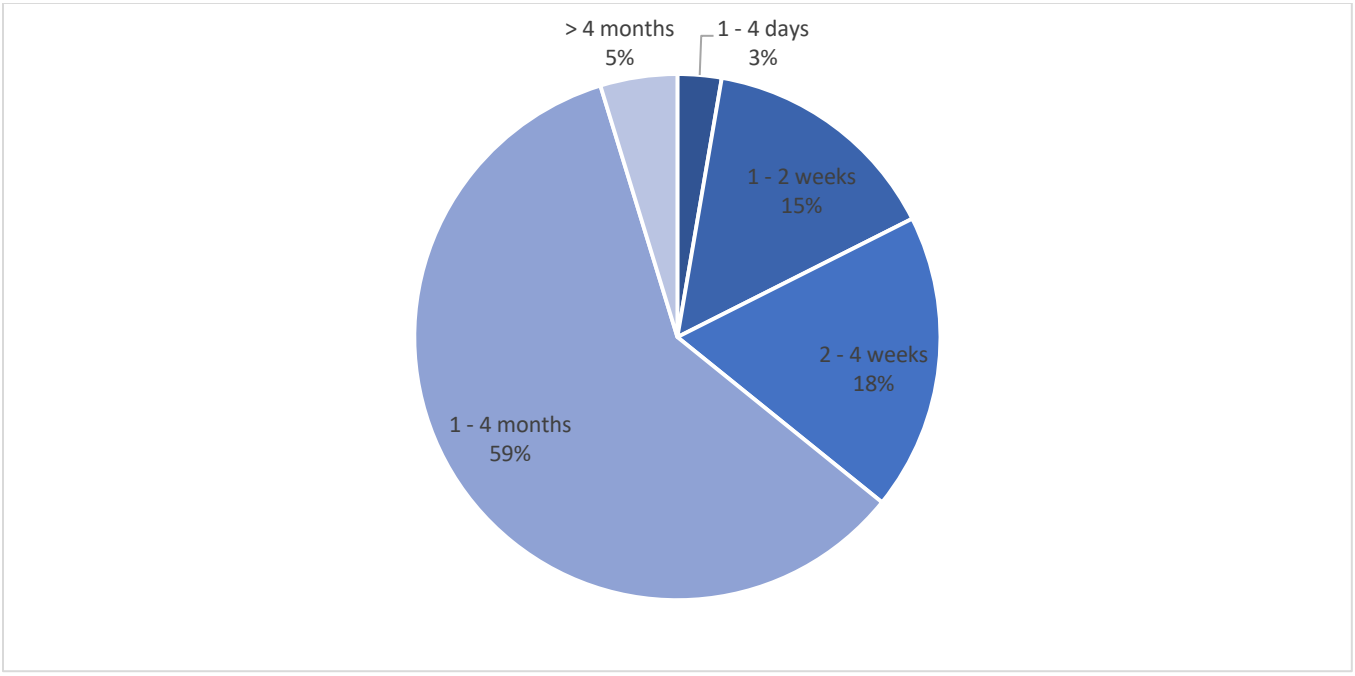
All Graduate Students (ICERM funded and Non-ICERM funded)

	Program Type	Summer@ICERM 2018	9 Collaboration Groups	Blackwell-Tapia	TRIPODS 1	TRIPODS 2	TRIPODS 3	Fall Semester '18						Spring Semester '19								Topical '18 - '19							
								Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Workshop 5	Research Cluster 1	% of # Reporting	Workshop A	Workshop B	Workshop C	Workshop D	Workshop E	Workshop F	Workshop G	% of # Reporting
Gender and Ethnicity	Total Participants	5	6	25	14	1	14	20	14	20	32	20		15	26	3	18	12	0	2		25	6	19	13	16	33	29	
	Female	2	4	9	7	0	4	9	7	7	12	8	41%	5	10	0	4	3	0	1	32%	7	2	3	4	3	12	10	32%
	Other	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	# Reporting Gender	4	6	25	14	0	8	20	14	20	31	20		15	25	1	18	12	0	1		22	5	17	13	15	30	20	
	African American	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	1	1	0	0	0	2%
	American Indian	0	0	0	0	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%	0	0	0	0	0	0	0	0%
	Asian	2	2	2	4	0	3	3	3	3	12	5	26%	5	12	0	6	5	0	0	40%	12	2	11	7	4	21	18	59%
	Hispanic	0	0	10	0	0	0	1	0	0	1	2	4%	2	0	0	0	1	0	0	4%	2	0	0	0	0	1	0	2%
	# Reporting Ethnicity	3	6	26	14	0	8	20	3	17	31	20		16	25	1	15	12	0	1		22	6	18	11	13	31	26	
Geographical Point of Origin	US Based	5	6	22	11	1	14	13	8	11	27	11	63%	12	24	2	13	8	0	2	80%	22	5	18	7	10	29	24	82%
	Foreign Based	0	0		3	0	0	7	6	9	8	9	37%	3	2	1	5	4	0	0	20%	3	1	1	6	6	4	5	18%

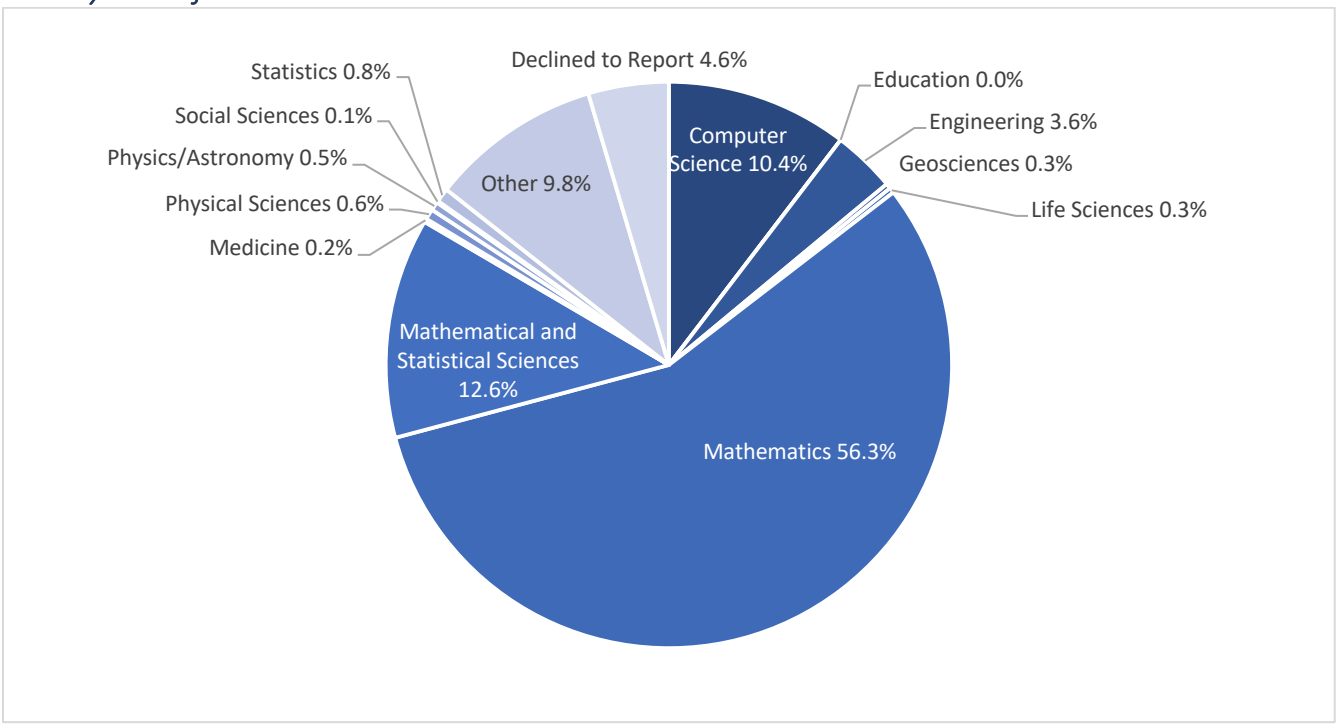
Additional Participant Data

The charts below display breakdowns of ICERM's confirmed participants by category during the reporting period for all funded programs. Each participant is only reflected once per chart regardless of the number of programs they attended.

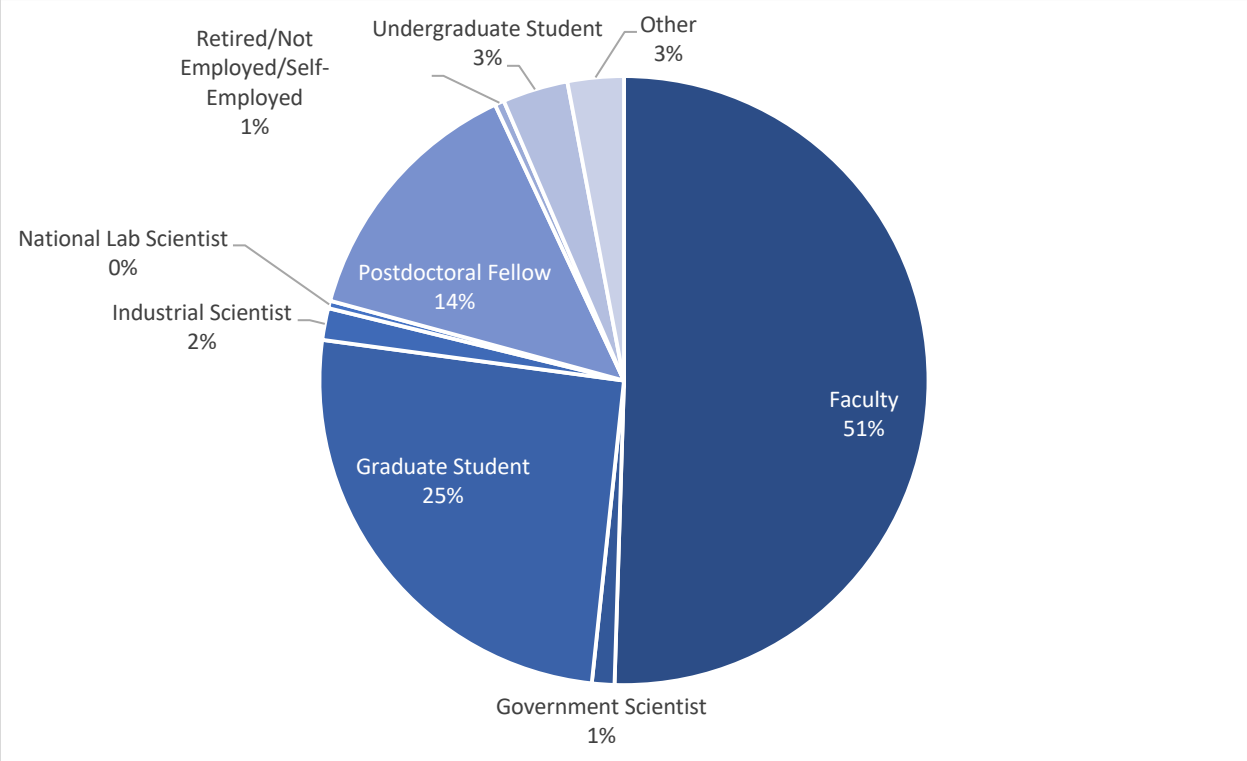
Semester Program Length of Stay



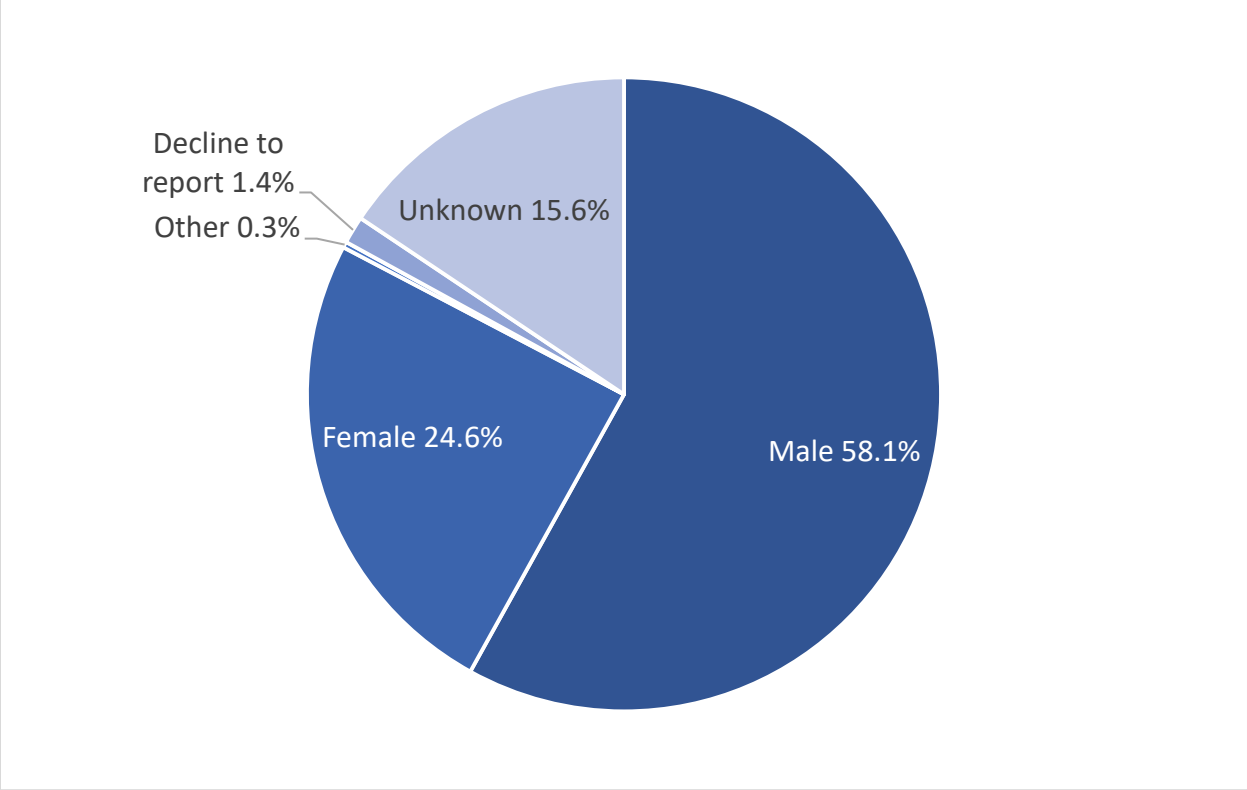
Primary Field of Interest



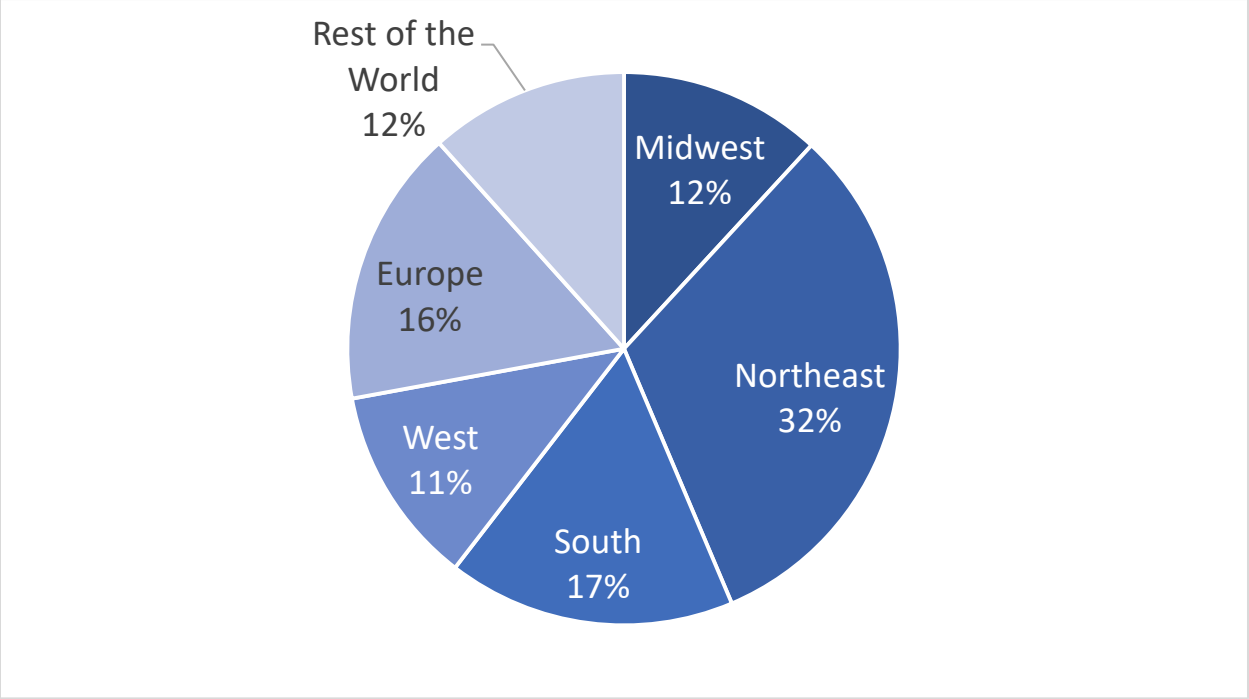
Position



Gender

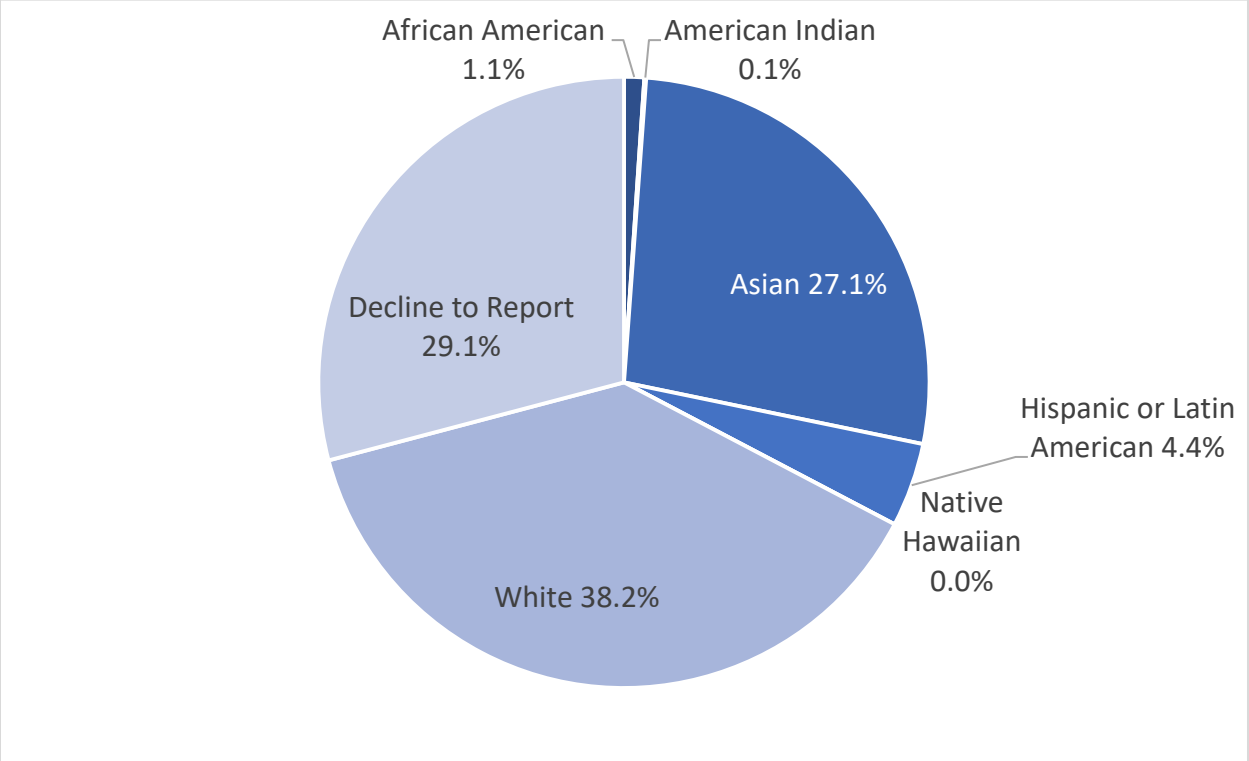


US vs Foreign Based Participants



Rest of the World includes: Africa, Asia, Canada, Latin & South America, and Oceania.

Ethnicity



Note: Participants can select multiple ethnicities so some are reflected in this pie chart more than once.

Semester Programs

Since its inaugural semester program in September 2011, a large portion of the Institute's activity has taken place in the context of semester long thematic programs together with their associated workshops. ICERM encourages proposals for programs that support its mission "to foster and broaden the relationship between mathematics and computation". The institute is open to proposals from any area of the mathematical sciences. Both pure and applied fields may benefit from the positive feedback between computation and theory that ICERM seeks to promote. ICERM Directors help proposers flesh out their ideas within the context of our mission; it is an iterative process, involving many conversations with ICERM Directors and proposal drafts in response to feedback from Directors and ICERM's boards, and fine-tuning after the event is publicly announced.

Semester Program Process

ICERM's Scientific Advisory Board SAB meets annually in November, and schedules conference calls as needed throughout the year. The 2018 annual meeting and a subsequent conference call in June resulted in the selection of semester programs and topical workshops through Spring 2021.

The semester program selection process follows these steps:

1. Solicitation of Proposals

ICERM hosts two semester programs per year. Each has organizers and long-term participants who are expected to be in residence for the majority of the semester. Semester programs typically incorporate three week-long associated workshops.

Semester Program Full Proposal Requirements

A semester program proposal should be 6-10 pages and contain:

- List of 5-10 organizers, including the main contact for organizing committee
- Short abstract of the program's basic goals and underlying philosophy
- Description of the program area/theme and central scientific challenges, written for a general mathematical audience
- Description of the experimental and computational aspects of the program
- Plans for ensuring the participation of underrepresented groups
- List of 8-10 high priority senior scientists likely to visit ICERM for a month or more
- Ranked list of 20+ potential long-term participants who will help form a critical mass for the scientific program
- Description of three proposed workshops, including potential organizers, if known
- Description of a 2-3 day opening event that will survey guiding problems or introduce key computational or experimental methodologies
- Concrete plans for involving and mentoring graduate students, postdocs, and early-career mathematicians in the program

Deadline and Review Process

Proposals are submitted to the ICERM Director. Annual target deadlines are October 1st and May 1st. ICERM Directors and the Scientific Advisory Board (SAB) review all proposals. Proposers receive feedback within a month of the SAB meeting.

2. Proposal Selection

The Science Advisory Board SAB approves the semester programs. The deadline for proposals is at least a week prior to the annual November SAB meeting. Proposals are usually sent out for review. Once a proposal is accepted, a member of the ICERM Directorate and members of a SAB subcommittee are assigned to assist the organizers who are also provided with a planning timeline. The "high priority" list of senior scientists are contacted and invited to participate immediately upon SAB approval. Program dates are scheduled with details posted on the ICERM website and various on-line math organization calendars SIAM, AMS, European Mathematical Society, National Math Institutes, and Conference Service Mandl. Program and/or workshop ads are placed in appropriate publications if recommended by the organizers and directors. ICERM reserves some funds for applicants (non-invitees) to the program.

From this point on, organizers are involved in making decisions on the following: ICERM postdoc selection; applications for long-term visitors, graduate students, and workshop participants; mentoring of students and postdocs (an institute Director assists the organizers with mentor coordination). Members of the Directorate make the final decisions on all invitations. A designated organizer assists ICERM staff by providing appropriate program images for web and print ads and will be asked to review marketing materials.

3. Selection of Long-term Visitors/Research Fellows

The organizers propose a ranked list of 20 to 30 research fellows. ICERM Directors approve and/or suggest additions or re-rankings in consultation with assigned SAB members. The standard model for long-term participation for senior faculty is through paid leaves such as sabbatical.

4. Offers to Research Fellows

Once the list of research fellows has been finalized and funding determined, an invitation is sent to each. The invitation describes the program and outlines the support to be provided. Using its Cube database, ICERM tracks demographic information about, and all interactions with, research fellows.

5. Semester Workshops

The semester program proposal should include a list of organizers for each of its three-to-four workshops. The organizers propose an initial ranked list of 20-25 possible speakers and a list of 10 alternates. The ICERM Directorate approves and/or suggests additions or re-rankings in consultation with assigned SAB members. Formal invitations are sent by ICERM staff describing the program and outlining the support to be provided to those who indicate an interest. A designated workshop organizer assists ICERM staff by providing appropriate program images for the workshop's web and print ads, and will be asked to review marketing materials.

6. Application Process

Once the organizers and Directors agree there is enough critical mass in terms of confirmed long-term visitors and/or workshop speakers, the on-line application for that particular program is opened on the ICERM website. All applications are stored in the institute's proprietary "Cube" database (see also the "Recruiting and Selection of ICERM-Funded Postdocs" later in this report). The ICERM postdoctoral fellow applicants who were not hired via MathJobs.org are

alerted that the ICERM postdoc positions have closed and that they should apply online for partial support to attend as a participant if they are still interested.

7. Applicant Selection

ICERM's proprietary "Cube" database and visitor management system is where participants go to apply for our programs. Program organizers can view the applicants and their supporting documents as well as rank them within Cube. A member of the ICERM Directorate reviews the ranked list, re-ranks as appropriate and makes the final selections, taking into consideration the remaining budget for the program, diversity, participant support requested, and whether or not the applicant is a young researcher who has an advisor already participating in the program. ICERM staff then updates the applicant about their status, and any support they are eligible for, as appropriate.

Financial Decisions for Semester Programs

Financial decisions are made by ICERM Directors based on discussions with organizers. For a typical program, ICERM provides travel and lodging support for 5-10 organizers (at least a month in residence, with some for the full semester); 20-30 long-term participants (4+ weeks); 1 Institute and 4 Semester postdoctoral fellows (salaried); 60 short-term participants (1-4 weeks); 10-15 graduate students (6+ weeks); and workshop attendees, some of whom ICERM supports with leftover funds. ICERM helps essential long-term participants negotiate sabbatical leaves or teaching releases to foster their participation.

Opening, "Middle" and Closing Events

Semester program opening and closing events are tailored to each program. Here are some examples of planned events during semester programs.

Opening event(s)

During the first week of program and can include:

- Opening reception
- 10-15 minute introductory presentations by the postdocs and grad students, designed to get everyone acquainted
- Talks related to upcoming workshops
- IT tutorial led by ICERM's IT staff

Weekly Seminar non-workshop weeks

- The weekly seminar includes talks by visitors in residence at ICERM. Program organizers are provided with names and dates to facilitate scheduling.

Mini-Series (Optional)

- Mini-courses or other multi-session events are encouraged.

Research Clusters (Optional)

A Research Cluster takes place during a semester program and is an independently organized research group activity in a focused subfield of that semester program.

A typical Research Cluster lasts at least 10 days, and as long as 4-6 weeks, and focuses on immediate progress on a major problem or on several problems of significance in the field of the program. In addition to the invited participants, interested faculty, postdocs or graduate students in residence at ICERM may participate in the research cluster.

The activity period begins with a collection of tutorials or a short possibly two-day workshop. The research activities, planned by the organizers, may consist of teamwork, daily/weekly seminars, and closing presentations. In collaboration with an ICERM director, Research Cluster organizers develop a list of 6-15 key scientists to form the core cohort of the cluster.

Prior to each of semester workshops (optional)

- Full-day tutorials the Thursday and Friday the week before each workshop
- Tutorials are given by long term visitors to the program

During Semester Workshops

- Workshops last 1 week and usually consist of 50-minute talks with 10 minutes of Q&A.
- Sometimes one afternoon is left "open" for collaborations and small groups
- A poster session is scheduled early in the workshop week
- Networking opportunities within workshops and semester programs, e.g., opportunities for women to come together for lunchtime discussions (optional)

Non-workshop weeks

- Lectures occur through either mini courses, research seminars, special talks, and/or computational working group meetings
- Young Researcher Seminar, where graduate students and postdocs meet sans faculty and discuss scientific questions
- Postdocs and grad students are mentored throughout the program, both informally and with formal professional development seminars and meetings

Final Event

During the first week of the program discussion about a closing event occurs with the organizing committee. Some possible models include:

- Short talks from all long-term visitors who are still in residence
- Special Colloquium to close out the event on the last day of the program
- Time set aside for takeaways
- Closing reception

Note: Sample schedules and organizer timelines can be found in Appendix A.

2018-2019 Semester Programs

Fall 2018 Semester Program: Nonlinear Algebra

September 5, 2018- December 7, 2018

Organizing Committee:

Dan Bates, U.S. Naval Academy

Sandra Di Rocco, Royal Institute of Technology, Stockholm
Jonathan Hauenstein, University of Notre Dame
Anton Leykin, Georgia Tech
Frank Sottile, Texas A&M University
Mike Stillman, Cornell University
Cynthia Vinzant, North Carolina State

Program Description:
The theory, algorithms, and software of linear algebra are familiar tools across mathematics, the applied sciences, and engineering. This ubiquity of linear algebra masks a fairly recent growth of *nonlinear algebra* in mathematics and its applications to other disciplines. The proliferation of nonlinear algebra has been fueled by recent theoretical advances, efficient implementations of core algorithms, and an increased awareness of these tools.

The benefits of this nonlinear theory and its tools are manifold. Pushing computational boundaries has led to the development of new mathematical theories, such as homotopy methods for numerical algebraic geometry, tropical geometry and toric deformations, and sums of squares methods for polynomial optimization. This uncovered many concrete nonlinear mathematical objects and questions, many of which are ripe for computer experimentation. In turn, resulting mathematical breakthroughs often lead to more powerful and efficient algorithms for computation.

This semester will work towards a time when ideas of nonlinear algebra, its theory, methods, and software are as ubiquitous as those of linear algebra.

All Long-term Visitors to Fall 2018 Semester Program (10+ Days)

Name	Institute	Days@ICERM
Bibhas Adhikari	Indian Institute of Technology Kharagpur	93
Carlos Améndola Cerón	Technical University Munich	21
Iman Bahmani Jafarloo	Politecnico di Torino	94
Dan Bates	U.S. Naval Academy	68
Daniel Bernstein	MIT	96
Greg Blekherman	Georgia Tech	67
Danielle Brake	University of Wisconsin - Eau Claire	99
Taylor Brysiewicz	Texas A&M University	93
Michael Burr	Clemson University	104
Dustin Cartwright	University of Tennessee	26
Melody Chan	Brown University	97
Justin Chen	Georgia Institute of Technology	94
Papri Dey	IIT Bombay	121
Alicia Dickenstein	University of Buenos Aires	26
Mareike Dressler	ICERM	94
Eliana Duarte Gelvez	Otto von Guericke University Magdeburg	39
Timothy Duff	Georgia Institute of Technology	87
Ricardo Fabbri	Rio de Janeiro State University	52
Oliver Gäfvert	KTH Royal Institute of Technology	86
Luis David Garcia Puente	Sam Houston State University	60

Elisa Gorla	University of Neuchatel	93
António Goucha	University of Coimbra	96
Katherine Harris	North Carolina State University	44
Jonathan Hauenstein	University of Notre Dame	90
Cvetelina Hill	Georgia Institute of Technology	93
Evelyne Hubert	Inria	31
Thomas Kahle	Otto-von-Guericke University	73
Kathlén Kohn	ICERM	140
Nidhi Kaihnsa	Max Planck Institute, MIS, Leipzig	59
Robert Krone	UC Davis	93
Kaie Kubjas	Sorbonne University	26
Sara Lamboglia	Goethe-University Frankfurt	96
Reinhard Laubenbacher	University of Connecticut Health Center	33
Kisun Lee	Georgia tech	94
Nan Li	Tianjin University	18
Diane Maclagan	University of Warwick	26
Giorgio Ottaviani	University of Florence	13
Elisa Palezzato	Hokkaido University	18
Dmitrii Pasechnik	Oxford University	97
Daniel Plaumann	TU Dortmund University	28
Kristian Ranestad	University of Oslo	88
Margaret Regan	University of Notre Dame	93
Felipe Rincón	Queen Mary University of London	21
Michael Ruddy	North Carolina State University	93
Georgy Scholten	North Carolina State University	96
Samantha Sherman	University of Notre Dame	93
Lily Silverstein	University of California Davis	99
Faye Pasley Simon	North Carolina State University	93
Rainer Sinn	FU Berlin	45

Here follows a sample of the most substantive comments from our long-term visitors:
Some Long-term Visitor Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *Through my work on the Sums-of-Squares package for Macaulay2 I have learned many new things about real algebraic geometry and non-negativity certificates. Especially coming together with experts like Diego Cifuentes and Mike Stillman was very valuable.*
- *I learned a couple of new interesting developments within this topic. On the one hand the workshop provided a very good and wide range of research talks and on the other hand the time between the workshops were filled with very good reading and working groups. I have gained so much new knowledge about topics like matrix completion, tropical geometry, and Newton-Okunkov bodies. And concerning the computational methods: Before coming to ICERM I was only familiar with Maple and Matlab; while being here I learned how to use and code in M2.*
- *Thanks to the program, I was able to greatly improve my understanding of theoretical principles and developments of computational algebraic geometry. I greatly value the bootcamp lectures that introduced many useful computational tools and methods and explained them in very accessible form.*

- *While at ICERM during the Nonlinear Algebra program I met many people who are experts in the field. This was and unique opportunity since most mathematicians working in the field were present at the same time and in the same place. The various workshops, working groups, and informal meetings were crucial to expanding my knowledge in both computational methodologies and theoretical developments in the field of nonlinear algebra.*
- *The most important thing I got out of my participation in the ICERM program is an overview of the current questions, and also who are (some of) the strongest young people in the field. The other concrete thing that I got out of participating was meeting some people at the other edge of the field (I am an algebraic geometer who has computational interests, and follows applied algebraic geometry - I was particularly interested to meet the engineers who have mathematical interests).*
- *My work weighs heavily on the computational side, especially numerical algorithms. The ICERM program gave me exposure to others working in the area who approach the subject more symbolically. It was also a chance to connect with some people who are interested in using the numerical approach to explore theoretical questions and to some who want to use it for engineering applications in computer vision.*
- *Experimental/computational: through visits from engineers in working groups and talks and through poster sessions. Theoretic: by inviting world experts to the program and by - in the real algebraic/optimization workshop - inviting speakers with a very theoretic background.*

Some Long-term Visitor Comments for "Briefly describe program highlights":

- *From my point of view the highlights of the program were the large number of researchers that visited the institute and the great quality of the PhD students and postdocs.*
- *Diversity of topics covered in the workshops and the opportunity to talk with some of the greatest experts in the field.*
- *The highlight of this program for me was, by far, the new relationships I established with dozens of people in the field.*
- *There are many. But above all I enjoyed interacting with all long-term participants. Since there were so many people staying here over a longer period, I had the time to get to know their different research directions and carefully choose new coorperations.*
- *I learned much from the bootcamp and lectures and working groups. 2) I created many new contacts and we opened many new interesting topics. 3) I learned many new theoretical things. I was also great to have the opportunity to attend AGNES and other seminars at the department of mathematics. 4) It was great to become part of the community. Without the program, this could never happen. 5) I loved ICERM environment and Brown university altogether. It was great to live on campus, meet students, other colleagues from the university as well as from MIT, Harvard, and Northeastern University.*
- *The best part of the program is that so many people with similar interests come together every day. It is amazing how many new ideas come up and how easy it is to initiate a project or discuss a problem. This was my first experience of this type and it was wonderful. I met many people with similar research interests and started several new*

projects. I also was exposed to the newest research in the field and was able to talk to the persons conducting this research.

- *The community s fantastic and I had the opportunity to interact with many people, learn a great deal from them, make new scientific connections, and start new collaborations. It was a fantastic semester!*
- *My personal highlight was learning about connections to machine learning (both tropical aspects of machine learning, and uses of machine learning in computational algebraic geometry).*
- *Each day was productive and mathematically stimulating, for many reasons (an interesting talk, meeting someone new at lunch or a research meeting with another participant). Very well organized.*
- *The workshops were great! But I was also deeply impressed by all the activities in between workshops. Every day there was working group scheduled and it was hard to decide on which problems to work on.*
- *ICERM provided a fertile environment for meeting with colleagues (both new and old) with time to sit down and work out details that move the research forward. Talks aid this by showing the speakers' interests and revealing their newer ideas, but the real action happens afterward in one-on-one and small-group discussions.*

Workshop 1: Nonlinear Algebra Bootcamp

September 5, 2018-September 12, 2018

Organizing Committee:
Dan Bates, U.S. Naval Academy
Jonathan Hauenstein, University of Notre Dame
Anton Leykin, Georgia Tech
Frank Sottile, Texas A&M University
Mike Stillman, Cornell University
Cynthia Vinzant, North Carolina State

Program Description:
The primary goal of this opening workshop is to expose program participants to many of the methods and software packages relevant to this program. There will be introductory lectures and ample time for experimentation with methods and software under the tutelage of area experts and software developers.

Participant List Workshop 1

Name	**Institute**
Bibhas Adhikari	Indian Institute of Technology Kharagpur
Carlos Améndola Cerón	Technical University Munich
Iman Bahmani Jafarloo	Politecnico di Torino
Dan Bates	U.S. Naval Academy
Daniel Bernstein	MIT
Greg Blekherman	Georgia Tech
Danielle Brake*	University of Wisconsin - Eau Claire
Taylor Brysiewicz	Texas A&M University

Michael Burr	Clemson University
Melody Chan	Brown University
Justin Chen	Georgia Institute of Technology
Diego Cifuentes*	MIT
Papri Dey	IIT Bombay
Mareike Dressler	ICERM
Timothy Duff	Georgia Institute of Technology
Ricardo Fabbri	Rio de Janeiro State University
Oliver Gäfvert	KTH Royal Institute of Technology
Elisa Gorla	University of Neuchatel
António Goucha	University of Coimbra
Elizabeth Gross	University of Hawai'i at Manoa
Marc Harkonen	Georgia Institute of Technology
Katherine Harris	North Carolina State University
Jonathan Hauenstein*	University of Notre Dame
Cvetelina Hill	Georgia Institute of Technology
Thomas Kahle*	Otto-von-Guericke Unversit√§t
Nidhi Kaihnsa	Max Planck Institute, MIS, Leipzig
Kathlén Kohn	ICERM
Robert Krone	UC Davis
Sara Lamboglia	Goethe-Universit√§t Frankfurt
Reinhard Laubenbacher	University of Connecticut Health Center
Kisun Lee	Georgia tech
Anton Leykin	Georgia Tech
Nan Li	Tianjin University
Diane Maclagan*	University of Warwick
Elisa Palezzato	Hokkaido University
Daniel Plaumann	TU Dortmund University
Kristian Ranestad	University of Oslo
Margaret Regan	University of Notre Dame
Felipe Rincón	Queen Mary University of London
Elina Robeva*	MIT
Michael Ruddy	North Carolina State University
Georgy Scholten	North Carolina State University
Samantha Sherman	University of Notre Dame
Lily Silverstein	University of California Davis
Faye Pasley Simon	North Carolina State University
Rainer Sinn	FU Berlin
Luca Sodomaco	University of Florence
Frank Sottile*	Texas A&M University
Allen Stewart	Seattle University
Mike Stillman	Cornell University
Elias Tsigaridas	INRIA
Cynthia Vinzant*	North Carolina State
Dane Wilburne	Illinois Institute of Technology
Ke Ye	Chinese Academy of Sciences
Josephine Yu	Georgia Institute of Technology

*Workshop speaker

There was no exit survey for this bootcamp.

Workshop 2: Core Computational Methods

September 17, 2018-September 21, 2018

Organizing Committee:
Jesús De Loera, University of California, Davis
Wolfram Decker, Technische Universität Kaiserslautern
Andrew Sommese, University of Notre Dame
Mike Stillman, Cornell University

Program Description:
This workshop will focus on core algorithms in the three crucial areas in nonlinear algebra: numerical algebraic geometry, symbolic computation, and combinatorial methods. There have been tremendous advances in algorithms in these areas. As applications become more sophisticated, and require more computing resources, the basic algorithms and implementations need to step up to match the demand from applications. This workshop will bring together experts to exchange ideas on new algorithms that are needed and on improvement of existing ones. It will incite collaboration on hybrid algorithms involving computational methods from the three areas. Examples of open problems to be addressed include: certification of numerical methods, and combining numerical, symbolic and combinatorial methods to allow a much larger reach for decomposition algorithms.

Participant List Workshop 2

Name	Institute
Bibhas Adhikari	Indian Institute of Technology Kharagpur
Amir Ali Ahmadi*	Princeton University
Carlos Améndola Cerón	Technical University Munich
Iman Bahmani Jafarloo	Politecnico di Torino
Daniel Bernstein	MIT
Anna Bigatti*	University of Genova
Greg Blekherman	Georgia Tech
Ahmed Blidia	INRIA
Danielle Brake*	University of Wisconsin - Eau Claire
Taylor Brysiewicz	Texas A&M University
Peter Burgisser	Technical University Berlin
Michael Burr	Clemson University
Melody Chan	Brown University
Tianran Chen*	Auburn University at Montgomery
Justin Chen	Georgia Institute of Technology
Diego Cifuentes*	MIT
Jesús De Loera	University of California, Davis
Mark DeBonis	Manhattan College
Wolfram Decker	Technische Universit√§t Kaiserslautern
Papri Dey	IIT Bombay
Mareike Dressler	ICERM
Timothy Duff	Georgia Institute of Technology

David Eklund	DTU
Ricardo Fabbri	Rio de Janeiro State University
Oliver Gäfvert	KTH Royal Institute of Technology
Tingran Gao	The University of Chicago
Luis David Garcia Puente	Sam Houston State University
Elisa Gorla	University of Neuchatel
António Goucha	University of Coimbra
Elizabeth Gross*	University of Hawai'i at Manoa
Marc Harkonen	Georgia Institute of Technology
Jonathan Hauenstein	University of Notre Dame
Martin Helmer*	University of Copenhagen
Cvetelina Hill	Georgia Institute of Technology
Anders Jensen*	Aarhus Universitet
Matthias Köppe*	UC Davis
Thomas Kahle	Otto-von-Guericke Unversit√§t
Nidhi Kaihnsa	Max Planck Institute, MIS, Leipzig
Erich Kaltofen*	North Carolina State University
Kathlén Kohn	ICERM
Madhu Kiran C Kolli	North Carolina State University
Martin Kreuzer*	University of Passau
Robert Krone*	UC Davis
Sara Lamboglia	Goethe-Universit√§t Frankfurt
Kisun Lee	Georgia tech
Anton Leykin	Georgia Tech
Nan Li	Tianjin University
Diane Maclagan*	University of Warwick
Peter Olver	University of Minnesota
Tomas Pajdla	Czech Technical University in Prague
Elisa Palezzato	Hokkaido University
Chris Peterson*	Colorado State University
Daniel Plaumann	TU Dortmund University
Andrew Pryhuber	University of Washington
Kristian Ranestad	University of Oslo
Margaret Regan	University of Notre Dame
Yue Ren*	Max Planck Institute
Felipe Rincón	Queen Mary University of London
Jose Rodriguez*	University of Wisconsin-Madison
Michael Ruddy	North Carolina State University
Mahrud Sayrafi	University of Minnesota
Georgy Scholten	North Carolina State University
Samantha Sherman	University of Notre Dame
Lily Silverstein*	University of California Davis
Faye Pasley Simon	North Carolina State University
Rainer Sinn	FU Berlin
Luca Sodomaco	University of Florence
Andrew Sommese	University of Notre Dame
Frank Sottile	Texas A&M University
Allen Stewart	Seattle University
Mike Stillman	Cornell University

Bernd Sturmfels	MPI Leipzig
Matteo Tacchi	LAAS - CNRS
Simon Telen	KU Leuven
Elias Tsigaridas	INRIA
Cynthia Vinzant	North Carolina State
Elise Walker	Texas A&M University
Charles Wampler*	General Motors
Dane Wilburne	Illinois Institute of Technology
Ke Ye	Chinese Academy of Sciences
Ruriko Yoshida*	Naval Postgraduate School
Josephine Yu	Georgia Institute of Technology
Lihong Zhi*	Academia Sinica

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *Learned theoretical developments from the talks and explicit examples of computational methodologies presented by the speakers.*
- *During the course of this workshop, I have learned about the advantages of using CoCoa and Singular, that I plan to use in my own research. I also learned of some of the concrete applications of tropical geometry, which is an area of interest to me.*
- *Invited speakers spoke on a breadth of topics, some of which were brand new to me. I definitely gained some insight into new methodologies and theories I had never heard of before.*
- *Being surrounded by people working on non-linear algebra was definitely beneficial. However, the workshop was so large and so packed full of talks and activities that it was difficult to find time to apply any knowledge that was developed. Also, I am a relative outsider to a lot of the research which meant I would need to make new connections. I found this difficult.*
- *Much of my work involves the computation of the mixed volume of a polynomial system. During this workshop, I learned of at least 3 new tools and methods for computing this mixed volume, which I look forward to implementing into my work. I had a similar experience with many other algorithms and methodologies, which will be extremely valuable in my current research.*
- *I really appreciate this great opportunity that ICERM has given me. Even though I was only visiting for one week, I already developed new collaborations with quite a few researchers that I have never met before. Some new ideas start to form in our short discussions, and I have no doubt that these 5 days will guide my research for the next few years.*
- *I have discovered a whole domain of research that I did not know, which is the tropical geometry, as well as applications of algebraic geometry that I ignored.*
- *I was able to connect to multiple researchers with whom I had never connected with at conferences before. The structure of the week at ICERM with the talks separated by well-timed coffee/tea breaks allowed for constant collaboration and time to ask further, more personalized questions to the speakers and other researchers.*

- *The meeting brought in many of the top people in the field. The talks covered the basic theory and many showed demos of their software, so it was clear how the methods can be used.*
- *Until this program I only knew very few basics about this topic. Due to the talks and conversations with other participants of the workshop I got a very broad insight into computational methologies and also a very good overview to the newest developments in this field. Particularly I enjoyed very much the poster session.*
- *I was really happy with the selection of speakers and topics. I learned a couple of new proof techniques. I was particularly impressed by Lily Silverstein's and Robert Krone's talks.*
- *I learned a lot about computations with polynomial systems using Bertini and Macaulay. I appreciated a lot learning about how Machine learning is used to improve algorithms in commutative algebra too.*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- *Having most of the world experts in numerical algebraic geometry together in the seminar room.*
- *Talking to Felipe Rincon about a paper he recently wrote on tropical ideal and discussing further research to be done in that area.*
- *Poster session allowed me to learn more details of fellow work of grad students; we even started a small group to explain and ask questions of one another! Collaboration has begun!*
- *One young participant gave a nice lecture. I had heard him in 2014, when his lecture was somewhat poor. I am glad to see his progress.*
- *I think the highlight of the workshop was the opportunity to enlarge the community of mathematicians I know. Independent of the mathematics, I was able to make some new connections and friendships. This is more important than the research.*
- *Talking with Thomas Kahle about Gaussoids. This looks like it will lead to a project. Also, talking to Elias Tsigaridas about rigidity theory. Again, perhaps another project.*
- *Though I have trouble naming a single high point of this workshop, to me, the most valuable part is to have this bird's-eye view of this entire field. The diversity of the topics really helped me to see the breadth of this field.*
- *Discussions with Martin Helmer, Mike Stillman, and Wolfram Decker on computational intersection theory and previous work done in those areas. This is important for me as I intend to work on this problem in my thesis. The AGNES meets ICERM event, organized by Bernd Sturmfels after the AGNES conference on Sunday was also very useful.*
- *I liked a lot learning about different computational methods and software used in some of the areas I usually work on.*
- *After Jose Rodriguez's talk, in conversations with him, we realized how to use his methods in a new algorithm to solve polynomia systems with an unusual (small Galois group), which are classified.*
- *The highlight for me was to be able to discuss my research projects with others who are more senior in the field, who could offer perspectives that have grown into new research projects and collaborations.*

- *As a senior person, I already know the senior people and their work. It has been good to re-connect with them, but my most novel interactions have been with the graduate students. The poster session was a good way to see their developing ideas and to get to know the new faces coming up in our field.*
- *- The poster session. - Meeting many peers of this topic (Kaltofen, Decker etc.)*
- *The reduction of the Hilbert series computation to regular languages in Robert Krone's talk was really impressive. In Diane Maclagan's talk I finally understood several of the computational foundations of tropical geometry with valuations (the case with trivial valuations being well-known).*
- *The talk of Chris Petersen was extremely inspiring for me.*

Workshop 3: Real Algebraic Geometry and Optimization

October 15, 2018-October 19, 2018

Organizing Committee:
Greg Blekherman, Georgia Tech
Didier Henrion, CNRS
Pablo Parrilo, Massachusetts Institute of Technology
Rekha Thomas, University of Washington
Cynthia Vinzant, North Carolina State

Program Description:
This workshop will focus on techniques and structures in real algebraic geometry and optimization, including computational tools for semi-algebraic sets, semidefinite programming techniques for polynomial optimization, and applications of these tools to problems in computer vision. Real algebraic geometry provides powerful tools to analyze the behavior of optimization problems, the geometry of feasible sets, and to develop new relaxations for hard non-convex problems. On the other hand, numerical solvers for semidefinite programs have led to new fast algorithms in real algebraic geometry. Algebraic methods over the real numbers are essential for many real-world applications. This workshop aims to explore the cutting edge of techniques in real algebraic geometry and convex optimization as well as applications of these tools to problems in computer vision and other information sciences.

Participant List Workshop 3

Name	Institute
Jose Acevedo	Georgia Tech
Bibhas Adhikari	Indian Institute of Technology Kharagpur
Jason Altschuler	MIT
David Anderson	Ohio State University
Albert Atserias*	Universitat Politècnica de Catalunya
Iman Bahmani Jafarloo	Politecnico di Torino
Krishnakumar Balasubramanian	UC Davis
Loretta Barolini	Springer
Daniel Bernstein	MIT
Greg Blekherman	Georgia Tech

Danielle Brake	University of Wisconsin - Eau Claire
Petter Branden*	KTH Royal Institute of Technology
Taylor Brysiewicz	Texas A&M University
Sabine Burgdorf*	University of Konstanz
Peter Burgisser	Technical University Berlin
Michael Burr	Clemson University
Marcel Celaya	Georgia Institute of Technology
Melody Chan	Brown University
Yanlai Chen	University of Massachusetts, Dartmouth
Justin Chen	Georgia Institute of Technology
Diego Cifuentes*	MIT
Timo de Wolff*	Technical University Berlin
Papri Dey	IIT Bombay
Sandra Di Rocco	Royal Institute of Technology, Stockholm
Nicholas Dicati	unknown
Mareike Dressler	ICERM
Eliana Duarte Gelvez	Otto von Guericke Universität Magdeburg
Timothy Duff	Georgia Institute of Technology
Rebecca Durst	Brown University
David Eklund	Technical University of Denmark
Alperen Ergur	TU Berlin
Ricardo Fabbri	Rio de Janeiro State University
Jeová Farias Sales Rocha Neto	Brown University
Hamza Fawzi*	University of Cambridge
Oliver Gäfvert	KTH Royal Institute of Technology
Fulvio Gesmundo	University of Copenhagen
Saeed Ghadimi	Princeton University
Elisa Gorla	University of Neuchatel
António Goucha	University of Coimbra
João Gouveia*	University of Coimbra
Alexandros Grosdos Koutsoumpelias	Osnabrück University
Elizabeth Gross	University of Hawai'i at Manoa
Georgina Hall*	INSEAD Business School
Marc Harkonen	Georgia Institute of Technology
Heather Harrington	University of Oxford
Katherine Harris	North Carolina State University
Jonathan Hauenstein	University of Notre Dame
Kathryn Heal	Harvard University
Martin Helsø	University of Oslo
Bill Helton	University of California San Diego
Didier Henrion	CNRS
Cvetelina Hill	Georgia Institute of Technology
David Hyeon	Seoul National University
Anders Jensen	Aarhus Universitet
Jaewoo Jung	Georgia Institute of Technology
Zuzana Kúkelová*	Czech Technical University
Nidhi Kaihnsa	Max Planck Institute, MIS, Leipzig
Sara Kalisnik Verovsek	Max Planck Institute for Mathematics in the Sciences
Seoyoung Kim	Brown University

Kathlén Kohn	ICERM
Pravesh Kothari*	Institute for Advanced Study and Princeton University
Khazhgali Kozhasov	MPI MiS
Robert Krone	UC Davis
Wai Yeung Lam	Brown University
Sara Lamboglia	Goethe-Universität Frankfurt
Jean B. Lasserre	LAAS-CNRS Toulouse
Kisun Lee	Georgia tech
Anton Leykin	Georgia Tech
Victor Magron	CNRS
Zhiping Mao	Brown University
Peter Merkx	Wesleyan University
Ali Mohammad-Nezhad	Purdue University
Ankur Moitra*	MIT
Bernard Mourrain	INRIA
Riley Murray	California Institute of Technology
Simone Naldi	Université de Limoges
Jiawang Nie	UCSD
Peter Olver	University of Minnesota
Tomas Pajdla	Czech Technical University in Prague
David Palmer	Massachusetts Institute of Technology
Pablo Parrilo	Massachusetts Institute of Technology
Dmitrii Pasechnik	Oxford University
Chris Peterson	Colorado State University
Andrew Pryhuber	University of Washington
Yang Qi	University of Chicago
Kristian Ranestad	University of Oslo
Annie Raymond*	University of Massachusetts, Amherst
Alexander Razborov*	University of Chicago
Margaret Regan	University of Notre Dame
Michael Ruddy	North Carolina State University
Mohab Safey El Din*	Sorbonne University
James Saunderson*	Monash University
Claus Scheiderer*	Universität Konstanz
Georgy Scholten	North Carolina State University
Tselil Schramm*	Harvard/MIT
Anna Seigal*	UC Berkeley
Yoshiyuki Sekiguchi	Tokyo University of Marine Science and Technology
Isabelle Shankar	University of California, Berkeley
Samantha Sherman	University of Notre Dame
Lily Silverstein	University of California Davis
Faye Pasley Simon	North Carolina State University
Rainer Sinn*	FU Berlin
Luca Sodomaco	University of Florence
Joungmin Song	GIST
Dogyoon Song	MIT
Nikhil Srivastava*	UC Berkeley
Bernd Sturmfels*	MPI Leipzig
Agnes Szanto	North Carolina State University

Xindong Tang	University of California, San Diego
Xiaoxian Tang	Texas A&M University
Thorsten Theobald	Goethe University Frankfurt
Louis Theran	University of St Andrews
Rekha Thomas	University of Washington
Matthew Trager*	NYU
Elias Tsigaridas	INRIA
Levent Tuncel*	University of Waterloo
Mauricio Velasco*	Universidad de Los Andes
Nelly Villamizar	Swansea University
Cynthia Vinzant	North Carolina State
Madeleine Weinstein	University of California Berkeley
Dane Wilburne	Illinois Institute of Technology
Zi Yang	UC San Diego
Josephine Yu	Georgia Institute of Technology
Chenyang Yuan	MIT
Lihong Zhi	Academia Sinica
Yuyu Zhu	Texas A&M University

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *As a non-expert in the field, I found the talks given quite informative, and at a good level of understanding.*
- *The workshop at ICERM allowed me to learn about computational techniques which I would otherwise have not been exposed to at my own university, since the workshop covered topics that faculty members at my home institution do not study. This allowed me to combine my own course and research knowledge with the information presented in the talks. I was also able to meet with collaborators about papers which I had read in the past and discuss specific nuances which were hard to assess over email.*
- *I learned about exciting new developments and got to know young researcher I hadn't met before.*
- *I was talking to Bernd Sturmfels and realized that his work is closely connected with mine. I also found answer to some of my questions regarding the algebraic boundary of rank1 region. I had nice discussions with some other people too.*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- *This was a really great workshop! The talks were of very high quality. The topics covered were diverse, ranging from real algebra / optimization to computer science. It gave me the opportunity to talk to people from these different communities that I otherwise would not have the chance to talk to.*
- *The highlight, for me, was the wonderful selection of talks and group of people that the organizers brought together. The talks were uniformly of a very high standard, on a range of topics that was broad and interesting but not too broad to be inaccessible.*
- *The great variety of talks presented and the opportunity to talk to some of the biggest experts in the field.*

- *The diversity and extremely high quality of most talks. This was an absolutely first rate workshop, one of the best ones I have ever attended.*
- *Many great chances to chat with excellent researchers from all of the world during the coffee breaks.*
- *I heard many exciting talks. The one by Petter Branden perhaps was the most surprising and impressive. Besides the scientific contents, ICERM's lecture hall is fantastic. The infrastructure is perfect and I find it a truly inspiring place.*
- *I enjoyed learning about recent developments in hyperbolic polynomials, from James Saunderson's and Nikhil Srivastava's talks.*
- *For me, the highlight of the workshop was the opportunity to make new scientific connections at the women's lunch. All of the scientific connections I made throughout the week will be useful to me in my future research, but the added component of the lunch with graduate students through senior researchers allowed me to grow my network in deeper and more long-lasting ways.*
- *All talks were at very high level and gave a broad view of the research panorama in this topic. I have been particularly impressed by some talks which are far from my mathematical interests but made me want to learn more about the topic.*

Workshop 4: Nonlinear Algebra in Applications

November 12, 2018-November 16, 2018

Organizing Committee:
Alicia Dickenstein, University of Buenos Aires
Elisa Gorla, University of Neuchatel
Jonathan Hauenstein, University of Notre Dame
Yang-Hui He, City, University of London, Oxford University, and Nankai University
Caroline Uhler, MIT

Program Description:
Applications often pose many algorithmic, computational, and theoretical challenges, and overcoming these challenges has been a driving force behind many recent innovations in nonlinear algebra. This workshop will bring together mathematicians and practitioners with a focus on recently developed methods that have been motivated by solving problems arising in applications. Three key hallmarks of the methods presented are efficient computation of solutions, exploitation of structure, and reformulation of numerically unstable systems. Some of the topics planned for discussion include algebraic cryptanalysis and coding theory, chemical reaction networks, computational biology, computer-aided geometric design, applications of enumerative and tropical geometry, gauge and string theory in physics, and applications to statistics such as probabilistic graphical models and singular learning theory.

Participant List Workshop 4

Name	Institute
Michael Adamer	University of Oxford
Bibhas Adhikari	Indian Institute of Technology Kharagpur
Elizabeth Allman*	University of Alaska Fairbanks
Iman Bahmani Jafarloo	Politecnico di Torino

Alessandra Bernardi*	Università di Trento
Daniel Bernstein*	MIT
Greg Blekherman	Georgia Tech
Danielle Brake	University of Wisconsin - Eau Claire
Taylor Brysiewicz	Texas A&M University
Michael Burr	Clemson University
Eimear Byrne*	University College Dublin
Dustin Cartwright	University of Tennessee
Melody Chan	Brown University
Venkat Chandrasekaran*	California Institute of Technology
Justin Chen	Georgia Institute of Technology
Lynn Chua	UC Berkeley
Diego Cifuentes	MIT
Mark Curiel	San Jose State University
Carina Curto*	The Pennsylvania State University
Jes√∫s De Loera	University of California, Davis
Pierre-Philippe Dechant	York St John University
Papri Dey	IIT Bombay
Sandra Di Rocco	Royal Institute of Technology, Stockholm
Alicia Dickenstein	University of Buenos Aires
Mareike Dressler	ICERM
Eliana Duarte Gelvez	Otto von Guericke Universität Magdeburg
Timothy Duff	Georgia Institute of Technology
Oliver Gäfvert	KTH Royal Institute of Technology
Luis David Garcia Puente	Sam Houston State University
Fulvio Gesmundo	University of Copenhagen
Elisa Gorla	University of Neuchatel
António Goucha	University of Coimbra
Alexandros Grosdos Koutsoumpelias	Osnabrück University
Elizabeth Gross	University of Hawai'i at Manoa
Alexander Guterman	Lomonosov Moscow State University
Marc Harkonen	Georgia Institute of Technology
Heather Harrington	University of Oxford
Jonathan Hauenstein	University of Notre Dame
Yang-Hui He	University of London, Oxford University, Nankai University
Martin Helmer	Centre for Applicable Mathematics
Bill Helton	University of California San Diego
Willy Hereman	Colorado School of Mines
Cvetelina Hill	Georgia Institute of Technology
Evelyne Hubert*	INRIA
Anthony Iarrobino	Northeastern University
Sun Jang	University of Ulsan
Vishnu Jejjala*	University of Witwatersrand
Peter Joyce	Community College of Baltimore County at Catonsville
Thomas Kahle*	Osnabrück University
David Kahle	Baylor University
Karan Khathuria	University of Zurich
Kathlén Kohn	ICERM
Robert Krone	UC Davis

Kaie Kubjas	Sorbonne Université
Hiram López	Clemson University, Autonomous University of Aguascalientes
Sara Lamboglia	Goethe-Universität Frankfurt
Cristina Landolina	University of Neuchâtel
Christopher Langdon	Pennsylvania State University
Reinhard Laubenbacher	University of Connecticut Health Center
ChongGyu Lee	University of Illinois
Kisun Lee	Georgia tech
Robert Lewis	Fordham University
Anton Leykin	Georgia Tech
Felice Manganiello	Clemson University
Ivan Martino	Northeastern University
Gretchen Matthews*	Virginia Tech
Challenger Mishra*	ICMAT, Madrid
Peter Olver	University of Minnesota
Giorgio Ottaviani*	University of Florence
Tomas Pajdla*	Czech Technical University in Prague
Beatriz Pascual Escudero	Ecole Centrale de Nantes
Dmitrii Pasechnik	Oxford University
Elisa Perrone	MIT
Alexander Pilyavsky	Private
Mark Plecnik*	University of California, Berkeley
Tefjol Pllaha	University of Kentucky
Andrew Pryhuber	University of Washington
Kristian Ranestad	University of Oslo
Alberto Ravagnani*	University College Dublin
Margaret Regan	University of Notre Dame
Yue Ren	Max Planck Institute
Elina Robeva*	MIT
Jose Rodriguez*	University of Wisconsin-Madison
Michael Ruddy	North Carolina State University
Mohab Safey El Din	Sorbonne University
Hal Schenck*	Iowa State University
Georgy Scholten	North Carolina State University
Samantha Sherman	University of Notre Dame
Anne Shiu*	Texas A&M University
Joseph Silverman*	Brown University
Lily Silverstein	University of California Davis
Faye Pasley Simon	North Carolina State University
Michael Snarski	Brown University
Luca Sodomaco	University of Florence
Ivan Soprunov	Cleveland State University
Frank Sottile	Texas A&M University
Agnes Szanto	North Carolina State University
Xiaoxian Tang	Texas A&M University
Angelica Torres	University of Copenhagen
Ngoc Mai Tran	University of Texas at Austin
Cynthia Vinzant	North Carolina State
Dane Wilburne*	ICERM

Ruth Williams	University of California, San Diego
Josephine Yu	Georgia Institute of Technology

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *I have learnt about new developments in computing Groebner bases, on the user front-end, as well as on the new vectorized backends, sides. I had an excellent opportunity to interact with leading US and international researches on topics closely related to my ongoing work, and was able to make good progress on my projects due to these very interactions.*
- *I have met colleagues who showed me faster methods to run some computations important for my research, for example Mohamed Safey el Din showed me the Maple implementation of Faugere algorithm to get Groebner basis (used in elimination procedures) and Robert Lewis showed me the use of Dixon resultant.*
- *It was great to see the new applications of nonlinear algebra in diverse fields, including computational neuroscience, networks, social media, physics, etc.*
- *I learned a great deal from Alessandra Bernardi's talk on (symmetric and cactus) rank of tensors, which in turn led to further discussions with Elias Tsigaridas and Joe Kileel.*
- *The talks were extremely good quality and covered many topics in the area. I learned about several new directions I did not know about and learned new results in the directions I was already familiar with.*
- *All talks were very well prepared, including both theoretical and computational challenges. The long coffee breaks and lunch time are a great occasion to interact with other participants.*
- *Learned new computational techniques via a collaboration (wrote a paper during that week) and have learned novel theoretical concepts in algebraic geometry, statistics, tropical geometry etc as well.*
- *The speakers were really well selected to present new trends in non-linear algebra. There were many speakers I had never met before. This was really great.*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- The talks of Carina Curto and Giorgio Ottaviani - they were extraordinary.
- I had the opportunity to work with Evelyne Hubert who was there during the workshop on a project that required joint expertise. I renewed my connections to Alicia Dickenstein. The session organized by her was of most interest to me.
- The talks of Shiu, Harrington, Plecnik, Ottaviani.
- One of the most interesting talks in this workshop (in my opinion) was given by Carina Curto, especially with the presentation of "music" arising naturally in linear-algebraic models from neuroscience.
- The various topics of the talks, but all with a common ground were enlightening for someone who is beginning to deal with the applications of nonlinear algebra. There was a great amount of interesting mathematicians to meet there, and the structure and schedule of the workshop where better than probably any other that I have been to, making it easy

to start discussions and to consult the experts (especially because it was easy to visit them in their offices in a small break).

- The highlight was making connections with other researchers. After my presentation, there were a lot of good questions. I had a half hour conversation with three other researchers about my topic.
- The poster session really impressed me with a good quality of posters.
- Mixture of Applied and Theoretical math
- So many old friends/collaborators and new ones! I loved the lunch for women. Very interesting and informative. It was great to hear talks, especially from people I had never met. Great diversity of topics. Overall, a supportive environment. Great to get feedback on my research (comments on my talk). Plenty of break time to chat with collaborators (including those involved with 3 projects I am working on).
- The talks were a very high quality and the discussions extended throughout all the free time. It was wonderful to meet everyone but there still wasn't enough time-- that is the sign of a good workshop!
- Varied tools from nonlinear algebra, geometry and topology were presented in relation with several applications of interest, with time for questions and answers.
- the natural diversity - not been to a conference this diverse, both scientifically and in terms of people. Fantastically interactive and inspiring.
- I really enjoyed the diversity of application domains represented at the workshop. While the applications were all very different, they tied together nicely through the underlying mathematics.
- The workshop did a really good job in presenting the breadth of non-linear algebra
- I very much enjoyed the variety of the applications presented in the talks. I was excited to see new questions in the area I have worked in. My plan is to start a project with one of the participants of the conference. ICERM has great facilities and friendly and helpful staff that made my stay very pleasant. Thank you!

Spring 2019 Semester Program: Computer Vision

February 4 - May 10, 2019

Organizing Committee:
Yali Amit, University of Chicago
Ronen Basri, Weizmann Institute of Science
Alex Berg, University of North Carolina, Chapel Hill
Tamara Berg, University of North Carolina, Chapel Hill
Pedro Felzenszwalb, Brown University
Benar Fux Svaiter, Instituto de Matemática Pura e Aplicada (IMPA)
Stuart Geman, Brown University
Basilis Gidas, Brown University
David Jacobs, University of Maryland
Olga Veksler, University of Waterloo

Program Description:

Computer vision is an inter-disciplinary topic crossing boundaries between computer science, statistics, mathematics, engineering and cognitive science.

Research in computer vision involves the development and evaluation of computational methods for image analysis. This includes the design of new theoretical models and algorithms, and practical implementation of these algorithms using a variety of computer architectures and programming languages. The methods under consideration are often motivated by generative mathematical models of the world and the imaging process. Recent approaches also rely heavily on machine learning techniques and discriminative models such as deep neural networks.

Problems that will be considered in the program include image restoration, image segmentation, object recognition and 3D reconstruction. Current approaches to address these problems draw on a variety of mathematical and computational topics such as stochastic models, statistical methods, differential geometry, signal processing, numerical algorithms and combinatorial optimization. Practical considerations also require the use of a wide variety of computational methods, including techniques that scale to large datasets.

The focus of the program will be on problems that involve modeling, machine learning and optimization. The program will also bridge a gap between theoretical approaches and practical algorithms, involving researchers with a variety of backgrounds.

All Long-term Visitors to Spring 2019 Semester Program (10+ Days)

Name	Institute	Dates@ICERM
Yali Amit	University of Chicago	76
Theresa Barton	Brown University	94
Ronen Basri	Weizmann Institute of Science	78
Muzammil Behzad	University of Oulu	99
David da Costa de Pinho	UENF	20
Timothy Duff	Georgia Institute of Technology	17
Ricardo Fabbri	Rio de Janeiro State University	24
Zhou Fang	Brown University	95
Jeová Farias Sales Rocha Neto	Brown University	95
Pedro Felzenszwalb	Brown University	95
Benar Fux Svaiter	IMPA	22
Tingran Gao	The University of Chicago	95
Davi Geiger	Courant Institute, NYU	95
Stuart Geman	Brown University	95
Basilis Gidas	Brown University	95
Alexander Grigo	University of Oklahoma	13
Anna Grim	Brown University	95
Shermin Hamzehei	University of Massachusetts, Amherst	95
David Jacobs	University of Maryland	95
Kathlén Kohn	ICERM	108
Shira Kritchman	The Weizmann Institute of Science	86
Han Cheng Lee	Brown University	81
Ziyin Ma	Brown University	81
F. PatriciaMedina	Worcester Polytechnic Institute	93

Michael Northington	Georgia Institute of Technology	90
Tomas Pajdla	Czech Technical University in Prague	17
Mario Parente	University of Massachusetts Amherst	79
Ömer Sümer	University of Tubingen	76
Kate Saenko	Boston University	10
Gabriel Taubin	Brown University	81
Shubhendu Trivedi	ICERM	239
Marilyn Vazquez	ICERM	272
Olga Veksler	University of Waterloo	76
Ying Wang	University of Oklahoma	97
Daphna Weinshall	Hebrew University of Jerusalem	95
Tomer Weiss	Wayfair	95
Jian-Zhou Zhang	Sichuan University	84
Guangyao Zhou	Brown University	150

Here follows a sample of the most substantive comments from our long-term visitors:
Some Long-term Visitor Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *Thanks to the program, I was able to greatly improve my understanding of theoretical principles and developments of computational algebraic geometry. I greatly value the bootcamp lectures that introduced many useful computational tools and methods and explained them in very accessible form.*
- *Due to my visit, I got the unique opportunity to exchange knowledge with several experts on recent developments. I was especially happy to discuss with Mike Stillman, Peter Olver, and Linda Ness the recently discovered numerical methods in computational invariant theory, which seem to have great potential.*
- *It was a great help in my research to be able to communicate with leading experts, in particular learn about recent developments at French INRIA and CNRS, as well as by Macaulay2 team.*
- *My work weighs heavily on the computational side, especially numerical algorithms. The ICERM program gave me exposure to others working in the area who approach the subject more symbolically. It was also a chance to connect with some people who are interested in using the numerical approach to explore theoretical questions and to some who want to use it for engineering applications in computer vision.*
- *I was able to get to know much better some of the younger people in the field, as well as some further afield. Even though I was an organizer and helped to invite many of them, the sustained interaction was very helpful. I started working with two of the participants, and wish I could have had more time to do even more.*
- *While at ICERM during the Nonlinear Algebra program I met many people who are experts in the field. This was and unique opportunity since most mathematicians working in the field were present at the same time and in the same place. The various workshops, working groups, and informal meetings were crucial to expanding my knowledge in both computational methodologies and theoretical developments in the field of nonlinear algebra.*
- *The boot camp helped me learning new computational tools that I did not use before. The presence of many experts was crucial to keep using these methods since I know I could*

always find someone to ask questions about them. The many workshops have broadened my knowledge on fields different from mine. Finally especially helpful and interesting have been the many working groups.

- *I learned a couple of new intersting developments within this topic. On the one hand the workshop provided a very good and wide range of research talks and on the other hand the time between the workshops were filled with very good reading and working groups. I have gained so much new knowledge about topics like matrix completion, tropical geometry, and Newton-Okunkov bodies. And concerning the computational methods:*
- *The most important thing I got out of my participation in the ICERM program is an overview of the current questions, and also who are (some of) the strongest young people in the field. The other concrete thing that I got out of participating was meeting some people at the other edge of the field (I am an algebraic geometer who has computational interests, and follows applied algebraic geometry - I was particularly interested to meet the engineers who have mathematical interests).*
- *ICERM enabled me to learn what is the cutting-edge of this very fast changing field in applied and computational mathematics.*
- *Through my work on the Sums-of-Squares package for Macaulay2 I have learned many new things about real algebraic geometry and non-negativity certificates. Especially coming together with experts like Diego Cifuentes and Mike Stillman was very valuable.*

Some Long-term Visitor Comments for "Briefly describe program highlights":

- *The community s fantastic and I had the opportunity to interact with many people, learn a great deal from them, make new scientific connections, and start new collaborations. It was a fantastic semester!*
- *I learned much from the bootcamp and lectures and working groups. 2) I created many new contacts and we opened many new interesting topics. 3) I learned many new theoretical things. I wa also great to have the opportunity to attend AGNES and other seminars at the department of mathematics. 4) It was great to become part of the community. Without the program, this could never happen. 5) I loved ICEMR environment and Brown university altogether. It was great to live on campus, meet students, other colleagues from the university as well as from MIT, Harvard, and Northeastern University.*
- *Diversity of topics covered in the workshops and the opportunity to talk with some of the greatest experts in the field.*
- *Excellent talks given by experts from all of the world. Discussions with students and postdoctoral fellow at ICERM.*
- *ICERM provided a fertile environment for meeting with colleagues (both new and old) with time to sit down and work out details that move the research forward. Talks aid this by showing the speakers' interests and revealing their newer ideas, but the real action happens afterward in one-on-one and small-group discussions.*
- *The best part of the program is that so many people with similar interests come together every day. It is amazing how many new ideas come up and how easy it is to initiate a project or discuss a problem. This was my first experience of this type and it was wonderful. I met many people with similar research interests and started several new projects. I also was exposed to the newest research in the field and was able to talk to the persons conducting this research.*

- *-Bootcamp: I learned new topics, new software and I could use exercise them working in a team -Working groups: amazing possibility of having many people and many different topics and also many experts in residence to ask questions and advice*
- *There are many. But above all I enjoyed interacting with all long-term participants. Since there were so many people staying here over a longer period, I had the time to get to know their different research directions and carefully choose new coorperations.*
- *My personal highlight was learning about connections to machine learning (both tropical aspects of machine learning, and uses of machine learning in computational algebraic geometry).*
- *The workshops were great! But I was also deeply impressed by all the activities in between workshops. Every day there was working group scheduled and it was hard to decide on which problems to work on.*
- *The lecture by James Sanderson in the Optrimization workshop was one highlight.*
- *Enjoyed Calabi YAU talks*
- *The highlight of this program for me was, by far, the new relationships I established with dozens of people in the field.*
- *From my point of view the highlights of the program were the large number of researchers that visited the institute and the great quality of the phd students and postdocs.*

Research Cluster 1: Algebraic Vision Research Cluster

January 28, 2019-February 15, 2019

Organizing Committee:
Ricardo Fabbri, Rio de Janeiro State University
Kathlén Kohn, ICERM

Program Description:
The powerful communication between mathematics and other scientific communities can be challenging. Notably, the interface between nonlinear algebra and computer vision has seen a boost of activity, giving rise to the Algebraic Vision community. At ICERM, this interface was jump-started at the Vision Working Group of the 2018 Nonlinear Algebra Program, when leading researchers came together to formulate new problems and solutions to push the field forward. We would like this activity to continue into the 2019 Computer Vision Program at ICERM, in the form of a research cluster, further bridging the fields to new levels.

Research Cluster 1 List

Name	**Institute**
David da Costa de Pinho	UENF
Timothy Duff	Georgia Institute of Technology
Ricardo Fabbri	Rio de Janeiro State
Hongyi Fan	Brown University
Jonathan Hauenstein	University of Notre Dame
Kathryn Heal	Harvard University
Joe Kileel	Princeton University
Benjamin Kimia	Brown University

Kathlén Kohn	ICERM
Anton Leykin	Georgia Tech
James Mathews	Memorial Sloan Kettering Cancer Center
Tomas Pajdla	Czech Technical University in Prague
Margaret Regan	University of Notre Dame
Michael Ruddy	North Carolina State University
Matthew Trager	NYU
Charles Wampler	General Motors

There was no exit survey for this research cluster.

Workshop 1: Theory and Practice in Machine Learning and Computer Vision

February 18, 2019-February 22, 2019

Organizing Committee:
Ronen Basri, Weizmann Institute of Science
Alex Berg, University of North Carolina, Chapel Hill
David Jacobs, University of Maryland

Program Description:
Recent advances in machine learning have had a profound impact on computer vision. Simultaneously, success in computer vision applications has rapidly increased our understanding of some machine learning techniques, especially their applicability. This workshop will bring together researchers who are building a stronger theoretical understanding of the foundations of machine learning with computer vision researchers who are advancing our understanding of machine learning in practice.

Much of the recent growth in the use of machine learning in computer vision has been spurred by advances in deep neural networks. At the same time, new advances in other areas of machine learning, including reinforcement learning, generative models, and optimization methods, hold great promise for future impact. These raise important fundamental questions, such as understanding what influences the ability of learning algorithms to generalize, understanding what causes optimization in learning to converge to effective solutions, and understanding how to make optimization more efficient.

The workshop will include machine learning researchers who are addressing these foundational questions. It will also include computer vision researchers who are applying machine learning to a host of problems, such as visual categorization, 3D reconstruction, event and activity understanding, and semantic segmentation.

Participant List Workshop 1

Name	**Institute**
Ben Abbatematteo	Brown University
Manuchehr Aminian	Colorado State University
Yali Amit	University of Chicago
Saed Asaly	Ariel University
Yuval Bahat	Technion - Israel Institute of Technology

Richard Baraniuk*	Rice University
Alessandro Barone	Emory University
Theresa Barton	Brown University
Ronen Basri*	Weizmann Institute of Science
Muzammil Behzad	University of Oulu
Mouhacine Benosman	MERL
Alex Berg	University of North Carolina, Chapel Hill
Yuri Boykov	University of Waterloo
Nathan Cahill	Rochester Institute of Technology
Jorio Cocola	Rice University
Nadav Cohen*	Institute for Advanced Study
Eva Comino	University of Southern Mississippi
Matt Corsaro	Brown University
Joseph Daws	University of Tennessee, Knoxville
Tali Dekel	Google
Eren Derman	Brown University
Deshana Desai	New York University
Keiko Dow	D'Youville College
Hasan Eruslu	University of Delaware
Zhou Fang	Brown University
Jeová Farias Sales Rocha Neto	Brown University
Pedro Felzenszwalb	Brown University
Rob Fergus*	Courant Institute of Mathematical Sciences
Katerina Fragkiadaki*	Carnegie Mellon
Tingran Gao	The University of Chicago
Davi Geiger	Courant Institute, NYU
Stuart Geman	Brown University
Basilis Gidas	Brown University
Tom Goldstein*	University of Maryland
Ming Gong	University of Dayton
Nakul Gopalan	Brown University
Anna Grim	Brown University
Sofia Guzzetti	Emory University
Benjamin Haeffele	Johns Hopkins University
Shermin Hamzehei	University of Massachusetts, Amherst
Tal Hassner*	Open University of Israel
Kathryn Heal	Harvard University
Fumi Honda	Brown University
Furong Huang*	University of Maryland
Shao Ran Huang	Brown University
Zhishen Huang	University of Colorado Boulder
Sorin Istrail	Brown University
David Jacobs*	University of Maryland
Numair Khan	Brown University
Benjamin Kimia	Brown University
Kathlén Kohn	ICERM
Shahar Kovalsky	Duke University
Shira Kritchman	The Weizmann Institute of Science
Henry Kvinge	Colorado State University

Svetlana Lazebnik*	University of Illinois, Urbana-Champaign
Triet Le	The National Geospatial-Intelligence Agency
Taehee Lee	Brown University
Han Cheng Lee	Brown University
Florencia Leonardi	University of Sao Paulo
Simin Li	Tsinghua University
Drew Linsley	Brown University
Karen Livescu*	Toyota Technological Institute at Chicago
Ziyin Ma	Brown University
Subhransu Maji*	University of Massachusetts, Amherst
James Martens*	Google DeepMind
Michael Patrick Martin	Johns Hopkins University
Jacob McCord	National Geospatial-Intelligence Agency
F. Patricia Medina	Worcester Polytechnic Institute
Sara Motlaghian	Georgia State University
Reshma Munbodh	Alpert Medical School of Brown University
Michael Northington	Georgia Institute of Technology
Tomas Pajdla	Czech Technical University in Prague
Ambar Pal	Johns Hopkins University
Mario Parente	University of Massachusetts Amherst
Andrew Peterson*	Brown University
Armenak Petrosyan	Oak Ridge National Laboratory
Dimitris Pinotsis	University of London ,Äî City and MIT
Farhad Pourkamali-Anaraki	University of Massachusetts Lowell
Qing Qu	New York University
Viktor Reshniak	Oak Ridge National Laboratory
Ömer Sümer	University of Tubingen
Kate Saenko*	Boston University
Ali Salehi	University of Memphis
Thomas Serre	Brown University
Hanieh Shabanian	University of Memphis
Mahdi Soltanolkotabi*	University of Southern California
Amara Tariq	Forman Christian College (A Chartered University)
Gabriel Taubin	Brown University
Matus Telgarsky*	University of Illinois Urbana-Champaign
Naftali Tishby*	Hebrew University
James Tompkin	Brown University
Shubhendu Trivedi	ICERM
Eli Upfal	Brown University
Marilyn Vazquez	ICERM
Olga Veksler	University of Waterloo
Rene Vidal*	Johns Hopkins University
Ying Wang	University of Oklahoma
Haixu Wang	Florida State University
Daphna Weinshall*	Hebrew University of Jerusalem
Tomer Weiss	Wayfair
Buren Wells	University of Alabama in Huntsville
Neda Yazdianpour	Georgia state university
Rujie Yin	Verily

Rich Zemel*	University of Toronto
Jian-Zhou Zhang	Sichuan University
Zhengwu Zhang	University of Rochester
Fan Zhang	Harvard Medical School
Guangyao Zhou	Brown University
Hao Zhou	University of Maryland
Lingjiong Zhu	Florida State University

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *This was one of the best workshops I have ever attended. I can't remember a better one. The subject of understanding deep neural networks is complex and fascinating. The talks were all of excellent quality and one talk connected to another. I felt like working on every topic raised by each talk. Fortunately, we made a group, of researchers staying here for longer time, to focus on one topic that related to a few of the talks. I am very excited to follow up on this research/collaboration we are creating, and more generally I understood the topic much better. The environment was excellent, where researchers were being candid and interested in sharing and discussing their knowledge. This workshop will have a great impact on my future work.*
- *This was my first time visiting ICERM, for the computer vision workshop in February. While I have knowledge of the basics of modern deep nets, the talks delving into both modern theoretical work and extremely application-driven research gave me many new ideas to consider bringing into my own research. In particular, the insights several presentations showed on accelerated convergence of deep nets by insertion of linear layers is intriguing, and the idea of adversarial domain adaptation is something our group may be investigating further in the future. While not directly related to the workshop events, I think it's worth noting that the ICERM staff and the organizers have created and maintained a clean, non-nonsense space which enabled me to not need to think about anything aside from the events at the workshop. The staff's efforts in taking care of lodging in the nearby Hampton with no need for reimbursement forms, etc, was also greatly appreciated.*
- *This is by far one of the best workshops that I have ever attended. I am of course a resident at the institute, and had the advantage of familiarity. However, I am used to extremely large meetings in ML and Vision, so much so that they are almost always not good for networking and deep dives. This workshop bought together people from old school and the newest areas of work in computer vision, and the small size ensured that I could get to know many people reasonably well. I developed one collaboration that started just during the workshop -- simply owing to the fact that someone senior with exactly complimentary expertise in a problem that I have thought of for a while was around -- and we could start working out details immediately. I am also sure many more will develop from connections that were made here.*
- *There, some data scientists talked to me, and one of them even shared a recent paper with me, and asked me if his method can solve some of my own theoretical machine learning problems. This might potentially lead to a future collaboration. I'm very happy about*

that. The only downside about this workshop is that there're a lot of applied talks, but not enough theoretical talks. But that's just from my own bias.

- *The theory and practice in machine learning workshop was one of the truly amazing workshops I have ever been to. Nowadays all conferences are extremely crowded / have too many parallel tracks. This workshop was very nicely paced, I could connect with other people, clear doubts and much more. This has been an enlightening week for me.*
- *The fields of Computer Vision and Machine Learning have been rapidly progressing in recent years. As a young researcher, it is difficult to have a clear understanding of this recent progress. This workshop's schedule was very balanced (from theory to practice) and helped me a lot. Also, some of the speakers presented an interesting perspective from the related fields (like information theory, geometry, and signal processing). In each session when I have a question, I found a chance to either directly ask during the sessions or in breaks. In general, the workshop helped me to increase my knowledge and better understand many open problems in CV/ML problems.*
- *Some of the talks in this workshop introduce prior and geometric regularization into machine learning which I thought was very creative to further achieving robustness in image and language understanding.*
- *I was able to hear from other people about the latest developments being made in their labs. In my opinion, having someone to explain their latest work in person is much more effective than reading about this work whenever it is eventually published.*
- *I am relatively new to the field of computer vision especially regarding what is done in practice. I enjoyed the variety that was displayed in the invited talks between theory and practice but especially enjoyed the practical applications discussed since they are mostly unknown to me.*
- *First of all, this workshop gives me an idea to enrich my paper by doing numerical experiment with real data. Second, I was inspired to combine optimization problem with deep learning. Last, before I attended the workshop, I stuck in a problem related to Stochastic Gradient Descent. There is one lecture showing me a different way to think about my research.*
- *First of all, being in such a positive and organized place and listening to a diverse set of presentations on different aspects of computer vision and machine learning topics made it possible for me to stop thinking in a very narrow-minded approach and start to see a bigger picture. Getting this high view is something that one cannot learn merely from papers. I think this is the most valuable knowledge that I gained from this workshop. I came to this workshop with a big list of questions and during the talks and discussions after them, I was able to learn answers for many of my questions and left the workshop with a several ideas to implement, many topics to study in depth, and a new set of questions to look for answers for them. Positively, it expedited all aspects of my research.*
- *By having the valuable opportunity to attend this workshop, I could learn about the recent developments of in this field, which helps me to make connections with my research field and inspire my new thought. I can also learn some methodologies and experience by discussing with other scholars to expand my research interests.*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- *I work on the applied side of computer vision and NLP. Therefore, the most important parts of the workshop for me were talks by Dr. Svetlana Lazebnik, Dr. Karen Livescue, and Dr. Kate Saenko.*
- *The workshop was super helpful for me to create new connections not only to the scientists, but also to some very significant research directions. Being surrounded by plethora of vision encyclopedia, I would definitely like to be part of such workshops in the future. All the credit goes to the ICERM team.*
- *The people, their attitude and their knowledge, the subject itself, and the level of contributions (which is a very good level, but also I was able to reach it, so not so impossible to reach to it). The subject itself is also of great interest, and the view presented by the workshop was what is missing for all of us to develop better theories and better understanding of these complex networks. The researchers staying here and the one visiting just for the workshop contributed for a great atmosphere and conversations.*
- *I really appreciated how the talks were well-balanced between applications and theory.*
- *Meeting with other colleagues in the field as well as having a relatively small venue which allow for significant interactions was a highlight.*
- *Some of the speakers are top notch people. Long coffee breaks so I can talk to people. Everything is done very professionally. Nice experience!*
- *The very nice pace of the workshop, with a good mixture of theory + practical talks, which helped keep the attention.*
- *For me personally the highlight is Dr. James Martens' talk on second order optimisation method and its KFAC form. I am glad that the workshop schedule has coincided with a public talk in general relativity, which I attended as well. Dr. Daphna Weinstall's talk is also very accessible.*
- *Meeting other PhD Students and sharing experiences and interests. Getting a huge amount of exposure to Machine Learning and Neural Networks.*
- *It was great that so many established researchers came and were enthusiastic about interacting with the younger scientists.*
- *I am a second year Ph.D. student in Computer Science. This workshop gave me a chance to understand the current trends, theoretical concerns, and new directions in the application. The schedule/speakers were not from a specific topic of machine learning and computer vision, instead, they were from different topics (theory of ML, face analysis, image/audio multimodal learning, etc.). Normally in workshops of conferences, the atmosphere is too formal and I do not feel free to ask my questions. And also, they are scheduled in a very tight program. However, during this week many times, I asked my questions directly to the presenters. It was very good to digest and understand better. Another important point for me is the inclusion of speakers from the theoretical side. Particularly the main CV community and conferences are heavily applicational. My PhD topic and research is also the application of CV/ML. Theoretical part (mostly, the ones on the explanation of deep learning) helped me to understand the issues and the current efforts to address them. As I am from an engineering background (electronics and CS), this part of the workshop gave me ideas to study and improve my background for future (i.e. which related disciplines of mathematics are needed to address and tackle problems in the theory of machine learning, and what I have missing, etc.).*
- *Coming from more of a mathematical perspective, Tom Goldstein's talk on "pessimistic" bounds for adversarial attacks was most intriguing for me, closely followed by the talks*

by Rene Vidal, Nadav Cohen, Matus Telgarsky, and Mahdi Soltanolkotabi. From the perspective of applications, Kate Saenko's talk on adversarial domain adaptation was most interesting to me.

- *The combination of practitioners and theoreticians added enough variety to the invited talks that I feel I was able to stay fully engaged for the full week.*
- *Very enlightening experience for someone relatively new to this field.*
- *What I really like about this workshop is people can ask questions freely during the talk. Since size of the workshop is small compared to CVPR, it is much easier to talk with other people.*
- *I got a better perspective on the importance of theories behind algorithms and in the same time, I realized that it is not necessary to completely postpone all experiments till learning all the math and theories behind the methods. It connected me to people in the math fields to discuss my research problems with them. Also, I was able to assist some of them that were new to computer vision and had practical problems. I got many ideas to apply to my research problem.*
- *Know other related researches and progress, which might help my current research and offer me a potential research direction in the future.*

Workshop 2: Image Description for Consumer and Overhead Imagery

February 25, 2019-February 26, 2019

Organizing Committee:
Trevor Darrell, University of California, Berkeley
David Jacobs, University of Maryland
Triet Le, The National Geospatial-Intelligence Agency
Guillermo Sapiro, Duke University
Eric Xing, Carnegie Mellon University

Program Description:
Building systems that can understand visual concepts and describe them coherently in natural language is fundamental to artificial intelligence. Advances in machine learning have had profound impact on computer vision and natural language processing. There has been interesting progress in recent years at the intersection of these two fields, producing systems that describe (eg., caption) images and videos captured by personal cameras in ordinary scenes and street views. Much work remains in this and a host of related problems, including that of building natural language descriptions of commercial overhead imagery and videos, where automation is greatly needed: "If we were to attempt to manually exploit the commercial satellite imagery we expect to have over the next 20 years, we would need eight million imagery analysts" [Robert Cardillo, NGA Director, GEOINT Symposium 2017]. This workshop brings together researchers in machine learning, computer vision, natural language processing to discuss best practices in machine generated descriptions for both consumer and overhead imagery and videos. Participants will identify challenges, and recommend future research topics.

Participant List Workshop 2

Name	Institute
Saed Asaly	Ariel University

Arslan Basharat*	Kitware
Ronen Basri	Weizmann Institute of Science
Muzammil Behzad	University of Oulu
Andrea Bertozzi*	UCLA
Vinicius Brei	Harvard University
Trevor Darrell*	University of California, Berkeley
Jared Dunnmon*	Stanford University
Jeová Farias Sales Rocha Neto	Brown University
Pedro Felzenszwalb	Brown University
Davi Geiger	Courant Institute, NYU
Stuart Geman	Brown University
Nakul Gopalan	Brown University
Anna Grim	Brown University
Shermin Hamzehei	University of Massachusetts, Amherst
Zhiting Hu*	Carnegie Mellon University
David Jacobs	University of Maryland
Shira Kritchman	The Weizmann Institute of Science
Triet Le	The National Geospatial-Intelligence Agency
Jacob McCord	National Geospatial-Intelligence Agency
F. Patricia Medina	Worcester Polytechnic Institute
Raymond Mooney*	The University of Texas at Austin
Michael Northington	Georgia Institute of Technology
Mario Parente*	University of Massachusetts Amherst
Michael Roberts	Cambridge University
Ömer Sümer	University of Tubingen
Kate Saenko	Boston University
Guillermo Sapiro*	Duke University
Hava Siegelmann	DARPA
Shubhendu Trivedi	ICERM
Marilyn Vazquez	ICERM
Rene Vidal*	Johns Hopkins University
Garret Vo	Department of Defense
Daphna Weinshall	Hebrew University of Jerusalem
Jian-Zhou Zhang	Sichuan University
An Zhang	Harvard University
Guangyao Zhou	Brown University

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *I was able to get a clear sense of cutting-edge methods in visual question answering and image captioning -- I really enjoyed the experience.*
- *Excellent array of speakers sparked some new ideas -- in particular Guillermo*
- *I thought that a few lectures were interesting, such as the one by Guillermo Shapiro. But others were less exciting, either because the work itself was not so interesting or because there were no efforts to discuss the scientific content.*

- *The workshop title did not correspond to most of the talks. I expected much more content about satellite imagery*
- *Super interactions, meet new people, had great open scientific discussions. Better than any of the major conferences.*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- *The highlight was a combination of the intimate setting of the talks, where very knowledgeable people folks interacted in an informal, scientifically engaged manner, and the breaks wherein I was able to discuss technical pieces with people in an informal setting.*
- *Despite a brief workshop, the research presentations were interesting and strengthened my motivations toward computer vision. Overall, for a beginner like me, the workshop was pretty helpful in developing for me a naive-level understanding of what computer vision can do!*

Workshop 3: Computational Imaging

March 18 2019-March 22, 2019

Organizing Committee:
Pedro Felzenszwalb, Brown University
Basilis Gidas, Brown University

Program Description:
Computational imaging involves the use of mathematical models and computational methods as part of imaging systems. Algorithms for image reconstruction have important applications, including in medical image analysis and imaging for the physical sciences. Classical approaches often involve solving large inverse problems using a variety of regularization methods and numerical algorithms.

Current research includes the development of new cameras and imaging methods, where the hardware system and the computational techniques used for image reconstruction are co-designed. New developments have been influenced by the introduction of novel techniques for compressed sensing and sparse reconstruction. The use of machine learning methods for designing a new generation of imaging systems has also been increasingly important.

Specific topics that will be discussed include: image reconstruction, computational photography, compressed sensing, machine learning methods, numerical optimization, sensor design, and applications.

Participant List Workshop 3

Name	**Institute**
Stephon Alexander	Brown University
Eman Alruwaili	Kent State University
Zhe Bai	Lawrence Berkeley National Lab
Weston Baines	Texas A&M University
Alberto Bartesaghi	Duke University

Ronen Basri	Weizmann Institute of Science
Kevin Beale	Georgia Institute of Technology
Muzammil Behzad	University of Oulu
Ralph Bording	Alabama A&M University
Carlos Borges	University of Central Florida
Katie Bouman	Harvard-Smithsonian Center for Astrophysics
Billy Braithwaite	University of Jyväskylä
Luca Calatroni	CMAP, École Polytechnique
Ayan Chakrabarti	Washington University in St. Louis
Li Cheng	University of Alberta
Julianne Chung	Virginia Tech
Victor Churchill	Dartmouth College
Michael Cohen	Facebook
Steve Damelin	University of Michigan - Sponsored Affiliate
Luke Decker	The University of Texas at Austin
Ian Dell'Antonio	Brown University
Deshana Desai	New York University
Agnès Desolneux	CMLA
S Dhawan	Central University of Haryana
Benedict Diederich	IPHT Leibniz Institute of Photonic Technology's
Malena Espanol	The University of Akron
Zhou Fang	Brown University
Jeová Farias Sales Rocha Neto	Brown University
Pedro Felzenszwalb	Brown University
Alessandro Foi	Tampere University
Bill Freeman	MIT
Benar Fux Svaiter	Instituto de Matemática Pura e Aplicada (IMPA)
Tingran Gao	The University of Chicago
Davi Geiger	Courant Institute, NYU
Stuart Geman	Brown University
Basilis Gidas	Brown University
Anna Grim	Brown University
Qi Guo	Harvard University
Shermin Hamzehei	University of Massachusetts, Amherst
Akhlaq Husain	BML Munjal University
David Jacobs	University of Maryland
Jiahua Jiang	Virginia Tech
Ajinkya Kadu	Utrecht University
Ulugbek Kamilov	Washington University in St. Louis
Tina Kapur	Brigham and Women's Hospital, Harvard Medical School
Numair Khan	Brown University
Benjamin Kimia	Brown University
Adam Klivans	University of Texas at Austin
Kathlén Kohn	ICERM
Shira Kritchman	The Weizmann Institute of Science
Kyros Kutulakos	University of Toronto
Han Cheng Lee	Brown University
Xiao Li	University of Southern California
Shuyang Ling	New York University

Ziyin Ma	Brown University
F. Patricia Medina	Worcester Polytechnic Institute
Seyedahmad Mousavi	University of Maryland, Baltimore County
Reshma Munbodh	Alpert Medical School of Brown University
Cristina Negoita	Oregon Institute of Technology
Kseniia Nepeina	Research Station RAS
Michael Northington	Georgia Institute of Technology
Ewa Nowara	Rice University
Lauren O'Donnell	Harvard University
Jaehee Park	CZ Biohub
Jing Qin	Montana State University
Qing Qu	New York University
Viktor Reshniak	Oak Ridge National Laboratory
Ömer Sümer	University of Tubingen
Amit Singer	Princeton University
Jasper Tan	Rice University
Gabriel Taubin	Brown University
Lei Tian	Boston University
James Tompkin	Brown University
Rob Tovey	University of Cambridge
Shubhendu Trivedi	ICERM
Marilyn Vazquez	ICERM
Ying Wang	University of Oklahoma
Li Wang	University of Texas at Arlington
Dong Wang	University of Utah
Tomer Weiss	Wayfair
William Wells	Harvard Medical School
Jian-Zhou Zhang	Sichuan University
Zhengwu Zhang	University of Rochester
Wenjin Zhou	UMass Lowell
Guangyao Zhou	Brown University
Zicong Zhou	University of Texas at Arlington
Xueyu Zhu	University of Iowa
Zhihui Zhu	Johns Hopkins University
Lilla Zollei	Harvard University

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *The workshop was the perfect combination of breadth and depth. I became aware of new problems and different ways of looking at problems I was already familiar with. The speakers were superb, and conversations were friendly and engaging. The setting was wonderful as well.*
- *The research talks are very interesting. Many presentations focus on the experiments and physical implementation of imaging devices (Cryo-EM, phase retrieval, etc.), and this provides me with a great overview of how things work in the lab. This type of information is perpendicular to my research and I find it very informative.*

- *ICERM organized a top-notch workshop with very strong invited speakers. It was great that many of the speakers stayed for many days, which enabled many discussions.*
- *I learned important details about several specific applications of imaging methods (both in medical imaging, biological imaging and astronomy) and also about theoretical developments in imaging in general.*
- *I learned about imaging the distribution of dark matter in the universe through gravitational lensing, and the Large Synoptic Survey Telescope has finally been constructed!*
- *I had interesting discussion with Davi Geiger on the formulation of a problem I have been working on, an estimation-theoretic approach to mutual-information-based image registration.*
- *All the lectures were very good. However, I believe it could add more flavor and interest specially to a Mathematician if the speakers can showcase some details of underlying theory along with computational/experimental results. Over all the workshop was very exciting and I was able to get a little insight into many new ideas, computational challenges in some of the very demanding problems of today in Computational Imaging.*
- *1. Learned of many imaging applications (imaging black holes, detecting dark matter, cryo-electron microscopy, surgical assistance, etc.) using computational methodologies 2. Learned about regularization techniques to address various problems 3. Learned about optical tools used for imaging objects in space (telescope arrays, etc.)*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- *hearing about the "image analysis" problems of astrophysics in trying to find dark matter from observations of many galaxies. This was fascinating from a general science point of view, but also, the methodology was interesting.*
- *The selection of speakers was very comprehensive. I enjoyed extensive interactions with them. Additionally, the workshop had a diverse set of attendees from graduate students to senior researchers.*
- *The presentation made by Tina Kapur was very interesting.*
- *The broad topics covered by the workshops was very interesting to me.*
- *Talking to mathematicians - it is not a crowd I get to spend much time with. Hearing about the LSST*
- *Several talks did a good job of updating me on state-of-the-art approaches to computational photography.*
- *MRI discussions - limits of imaging using ultrasound.*
- *I appreciated the breadth of the scope of the workshop and the profound expertise of the participants.*
- *Having the opportunity to talk with speakers after technical sessions*
- *Good timing during workshop. Well prepared lecture presentations besides those one*
- *Excellent invited speakers; long breaks allowing for conversations*
- *Due to my research focus, I am more interested in variational models and optimization algorithms in various imaging applications.*
- *Computational microscopy topics are fascinating*
- *Being able to listen to excellent researchers describe their work, and discuss possible avenues for future research with them and others.*

- *Amit Singer's talk on cryo em*
- *Learned various fields and applications that use a common set of computational ideas 2. Met faculty and students from other universities that I will probably meet again in the future*
- *Choice of speakers from various interdisciplinary domains working in the field of imaging techniques and algorithms. 2. Pace and organization of lectures was extremely good. 3. Time allotted for questions answers sessions between two consecutive lectures was just best. 4. Proper scheduling of lectures with sufficient breaks for coffee/lunch/snacks at regular intervals was also wonderful and helpful to refresh the participants.*

Workshop 4: Optimization Methods in Computer Vision and Image Processing

April 29, 2019-May 3, 2019

Organizing Committee:
Yuri Boykov, University of Waterloo
Pedro Felzenszwalb, Brown University
Benar Fux Svaiter, Instituto de Matemática Pura e Aplicada (IMPA)
Olga Veksler, University of Waterloo

Program Description:
Optimization appears in many computer vision and image processing problems such as image restoration (denoising, inpainting, compressed sensing), multi-view reconstruction, shape from X, object detection, image segmentation, optical flow, matching, and network training. While there are formulations allowing for global optimal optimization, e.g. using convex objectives or exact combinatorial algorithms, many problems in computer vision and image processing require efficient approximation methods.

Optimization methods that are widely used range from graph-based techniques and convex relaxations to greedy approaches (e.g. gradient descent). Each method has different efficiency and optimality guarantees. The goal of this workshop is a broad discussion of mathematical models (objectives and constraints) and robust efficient optimization methods (exact or approximate, discrete or continuous) addressing existing issues and advancing the state of the art.

Participant List Workshop 4

Name	Institute
Maicon Alves	Federal University of Santa Catarina
Yali Amit	University of Chicago
Theresa Barton	Brown University
Ronen Basri	Weizmann Institute of Science
Muzammil Behzad	University of Oulu
Ce Bian	University of Texas at Arlington
Matthew Blaschko*	KU Leuven
Yuri Boykov*	University of Waterloo
Billy Braithwaite	University of Jyväskylä
Steve Damelin	University of Michigan

Jerome Darbon*	Brown University
Akira Date	University of Miyazaki
Jonathan Eckstein*	Rutgers University
Fariba Fahroo	DARPA
Zhou Fang	Brown University
Jeová Farias Sales Rocha Neto	Brown University
Pedro Felzenszwalb*	Brown University
Tingran Gao	The University of Chicago
Guillaume Garrigos	Université Paris-Diderot
Davi Geiger*	Courant Institute, NYU
Stuart Geman	Brown University
Basilis Gidas	Brown University
Daniel Greenfeld	Weizmann Institute of Science
Alexander Grigo	University of Oklahoma
Anna Grim	Brown University
Keaton Hamm	University of Arizona
Shermin Hamzehei	University of Massachusetts, Amherst
Dorit Hochbaum	University of California, Berkeley
David Jacobs	University of Maryland
Fredrik Kahl*	Lund University
Benjamin Kimia	Brown University
Philip Klein	Brown University
Kathlén Kohn*	ICERM
Vladimir Kolmogorov*	Institute of Science and Technology (IST)
Simon Korman	The Weizmann Institute
Bala Krishnamoorthy	Washington State University
Shira Kritchman	The Weizmann Institute of Science
M. Pawan Kumar*	University of Oxford
Hiram López	Cleveland State University
Han Cheng Lee	Brown University
Qiuwei Li	Colorado School of Mines
En-Bing Lin	Central Michigan University
Feng Liu	Harvard Medical School
Yun Lu	Kutztown University
Sepideh Mahabadi*	Toyota Technological Institute at Chicago (TTIC)
Andreas Mang	University of Houston
Azita Mayeli	The Graduate Center and QCC, CUNY
Renato Monteiro	Georgia Tech
Seyedahmad Mousavi	University of Maryland, Baltimore County
Michael Northington	Georgia Institute of Technology
Ewa Nowara	Rice University
Carl Olsson*	Lund University
Augustine Osagiede	University of Benin
Tomas Pajdla*	Czech Technical University in Prague
Majela Pentón Machado	University Federal of Bahia
Pranjal Prasad	Virginia Tech
Gabriel Provencher Langlois	Brown University
Andrew Pryhuber	University of Washington
Qing Qu	New York University

Daniel Reichman	Princeton University
Hema Rubesh	Lady Doak College
Ronitt Rubinfeld*	Massachusetts Institute of Technology
Cynthia Rush*	Columbia University
Hermilo Sánchez-Cruz	Universidad Autónoma de Aguascalientes
Ningyu Sha	Michigan State University
Yeonjong Shin	Brown University
Mauricio Sicre	Universidade Federal da Bahia
Sudipta Sinha	Microsoft Research
Osvaldo Tapia Dueñas	Universidad Autonoma de Aguascalientes
Gabriel Taubin	Brown University
Rekha Thomas*	University of Washington
James Tompkin	Brown University
Matthew Trager	NYU
Marilyn Vazquez Landrove	ICERM
Olga Veksler*	University of Waterloo
Ying Wang	University of Oklahoma
Li Wang	University of Texas at Arlington
Daphna Weinshall	Hebrew University of Jerusalem
Yair Weiss*	Hebrew University of Jerusalem
Tomer Weiss	Wayfair
Michael Werman*	Hebrew University
Huiwen Wu	University of California, Irvine
Yangyang Xu	Rensselaer Polytechnic Institute
Ming Yan	Michigan State University
Jinkyu Yu	KAIST
Jian-Zhou Zhang	Sichuan University
Guangyao Zhou	Brown University
Zhihui Zhu	Johns Hopkins University

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *Excellent discussions with colleagues from around the world during the breaks. Nice balance of well curated talks, and adequate breaks during which we were able to exchange perspectives and make progress on open mathematical problems.*
- *I learned a good bit about how people in the imaging process think and analyze problems. But the extreme diversity of viewpoints made forging connections a bit harder than I expected.*
- *I feel I learned a lot about the latest experimental as well as some theoretical developments on optimization in vision from some of the select leaders from the field. The use and influence of deep learning is pervasive in vision these days, and I felt there was a good balance between experimental and theoretical topics presented in connection with deep learning.*
- *ICERM has given me an overall picture of the different ways of doing research in computer vision. I also feel glad that I had good collaboration.*

- *I learned about mathematical and computational techniques for image processing that I didn't know before.*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- *A colleague was able to improve a proof I had done recently to cover an interesting case. In presenting it, another colleague asked interesting questions that formed the outline of a complete proof for all cases :-)*
- *Being able to educate a diverse audience about the basics of convex analysis.*
- *This workshop covers very broad and up to date knowledge. Creating connections with others is very beneficial to me.*
- *Great picture of the current art in Computer Vision Most practitioners in the field participated at one time or another Broad spectrum of interesting talks Great Opportunity to exchange ideas and develop collaborations*
- *Learning new but related methods of image segmentation that I will look into*
- *Talks on use of optimization inside deep learning pipelines. In particular, work about robustifying deep networks training - I hope to do some work in that area with new connection(s) I made at this workshop.*

Workshop 5: Introduction to the ANTs Ecosystem

May 10, 2019

Organizing Committee:
Brian Avants, University of Virginia
Nick Tustison, University of Virginia

Program Description:

Advanced Normalization Tools (ANTs, originating at sourceforge.net on 2008-06-26 and now residing at https://github.com/ANTsX/ANTs) is a computational framework for quantitative biological image analysis. ANTs was first created by Brian Avants, Nicholas Tustison, and Gang Song (now at Google) as a way to rapidly disseminate the latest methodological research to the community of scientists who depend on imaging analytics and the flexibility to study different organ systems, species or modalities all within the same computational framework. While originally focused on diffeomorphic image registration, ANTs grew to incorporate methods for segmentation, feature extraction and, more recently, evolved into a multi-package ecosystem featuring full statistical pipelines via ANTsR (https://github.com/ANTsX/ANTsR), such as multiple modality inference of structural/functional relationships with neuroimaging, and deep learning functionality with ANTsRNet (https://github.com/ANTsX/ANTsRNet). This tutorial by the primary ANTs developers will introduce researchers to various software tools from the ANTs ecosystem with hands-on learning using publicly available data.

Participant List Workshop 5

Name	**Institute**
Brian Avants	University of Virginia
Muzammil Behzad	University of Oulu
Ailita Eddy	Brown University

Jeová Farias Sales Rocha Neto	Brown University
Marissa Gray	Brown University
Anna Grim	Brown University
F. Patricia Medina	Worcester Polytechnic Institute
Reshma Munbodh	Alpert Medical School of Brown University
Ziad Saleh	Brown University
Nick Tustison	University of Virginia
Marilyn Vazquez Landrove	ICERM
Tomer Weiss	Wayfair

There were no exit surveys collected by ICERM for this program.

Note: for a list of upcoming semester programs, see Appendix B.

Topical Workshops

ICERM's topical workshops run over 5 weekdays and focus on a timely and exciting theme that aligns with the institute's mission of supporting and broadening the relationship between mathematics and computation. ICERM hosts 5-7 topical workshops each year. They are typically scheduled in December, January, and May through August (around the dates of the semester programs).

1. Solicitation of Topical Workshop Proposals

A topical workshop proposal should be 2-4 pages and contain:

- List of 3-6 organizers, and the main contact for the organizing committee
- Description of the program area/theme, written for a general mathematical audience
- Description of the experimental and computational aspects of the program
- Plans for ensuring the participation of underrepresented groups

2. Topical Workshop Selection

Proposals are submitted to the ICERM Director. The Science Advisory Board (SAB) approves the topical workshops. The deadline for proposals is mid-October, prior to the annual November SAB meeting, and mid-May, prior to an annual conference call.

Approved program dates are scheduled and the workshop's lead organizer will assist ICERM staff by providing appropriate program images for web and print ads, and will be asked to review marketing materials. Details are posted on the ICERM website and various on-line math organization calendars SIAM, AMS, European Mathematical Society, National Math Institutes.

3. Recommendation of Speakers

The organizers propose a ranked list of 20-25 speakers, which the ICERM Directors approve and/or suggest additions or re-rankings in consultation with SAB members.

4. Invitations to Speakers

Once the list of workshop speakers has been finalized and funding determined, an invitation is sent to each. The invitation describes the workshop and outlines the support to be provided. Using its Cube database, ICERM tracks demographic information about, and all interactions with, speakers.

5. Application Process

Once the organizers and Directorate agree there is enough critical mass in terms of confirmed speakers, applications are opened and accepted on-line for that particular workshop.

6. Applicant Selection

ICERM's proprietary "Cube" database and visitor management system is where participants go to apply for our programs. Program organizers can view the applicants and their supporting documents as well as rank them within Cube. A member of the ICERM Directorate reviews the ranked list, re-ranks as appropriate and makes the final selections, taking into consideration the remaining budget for the program, diversity, participant support requested, and whether or not the applicant is a young researcher who has an advisor already participating in the program. ICERM staff then updates the applicant about their status, and any support they are eligible for, as appropriate.

Financial Decisions for Topical Workshops

Financial decisions are made by ICERM Directors based on discussions with organizers. ICERM covers travel and lodging expenses of the organizers and 20-25 invited speakers/lead participants; some participants (applicants) to the workshop may also be supported.

Topical Workshops in 2018-2019

ICERM hosted 7 topical workshops from May 2018 to April 2019. These workshops focus on topics of current interest in the mathematical sciences.

Topical Workshop 1: Birational Geometry and Arithmetic

May 14-18, 2018

Organizing Committee:
Asher Auel, Yale University
Marta Pieropan, EPFL
Sho Tanimoto, Kumamoto University
Yuri Tschinkel, New York University
Anthony Varilly-Alvarado, Rice University

Workshop Description:
Recent developments in the minimal model program in positive characteristic and birational geometry have found purchase within arithmetic geometry, e.g., around questions of exceptional sets involved in Manin's conjecture on points of bounded height. In turn, arithmetic perspectives

afforded by Manin's conjecture are starting to shed light on the geometry of spaces of rational curves.

Our goal in this workshop is to bring together two camps of geometers (birational and arithmetic) who have had few opportunities to interact on a large scale. We plan to focus on the interplay between theoretical developments and explicit constructions, e.g., in the study of Cox rings of Fano varieties, rationality problems, Manin's conjecture.

Participant List Topical Workshop 1

Name	**Institute**
Dan Abramovich*	Brown University
Shamil Asgarli	Brown University
Asher Auel	Yale University
Roya Beheshti*	Washington University
Dori Bejleri	Brown University
Jennifer Berg	Rice University
Alexander Best	Boston University
Dorin Boger	Harvard
Iacopo Brivio	University of California, San Diego
Morgan Brown	University of Miami
Diana Castaneda	University of Waterloo
Ivan Cheltsov*	University of Edinburgh
Edgar Costa*	Dartmouth College
John Cullinan	Bard College
Omprokash Das	University of California, Los Angeles
Ulrich Derenthal*	University of Oxford
Kevin Destagnol	Max Planck Institut für Mathematik
Gabriel Dorfsman-Hopkins	University of Washington
Taylor Dupuy	University of Vermont
Jordan Ellenberg*	University of Wisconsin
Anastassia Etropolski	Rice University
Christopher Frei*	University of Manchester
Tangli Ge	Brown University
Ravindra Girivaru	University of Missouri
Yoshinori Gongyo*	University of Tokyo
Adam Gyenge	University of British Columbia
Changho Han	Harvard University
Minsik Han	Brown University
Alicia Harper	Brown University
Sachi Hashimoto	Boston University
Brendan Hassett*	ICERM/Brown University
Fei Hu	University of British Columbia
DongSeon Hwang	Ajou University
David Hyeon	Seoul National University
Su-ion Ih	University of Colorado at Boulder
Giovanni Inchiostro	Brown University
Junmyeong Jang	University of Ulsan
Kiran Kedlaya*	University of California, San Diego

Simon Keicher*	n/a (previously Universidad de Concepcion, Chile)
Seoyoung Kim	Brown University
Amanda Knecht	Villanova University
Daniel Krashen*	Rutgers University
Justin Lacini	UC San Diego
Kuan-Wen Lai	Brown University
Brian Lehmann*	Boston College
Zhiyuan Li	University of Bonn
Yohsuke Matsuzawa	the University of Tokyo
James McKernan*	UCSD
Takumi Murayama	University of Michigan
Takuzo Okada*	Saga University
Jun Yong Park	University of Minnesota
Marta Pieropan	EPFL
Alena Pirutka*	NYU
Fazle Rabby	Texas Christian University
Eric Riedl	University of Illinois at Chicago
Cecília Salgado	UFRJ
Justin Sawon	University of North Carolina - Chapel Hill
Danny Scarponi	University of Regensburg
Akash Sengupta*	Princeton University
Joseph Silverman	Brown University
Joungmin Song	GIST
David Stapleton	UC San Diego
Jason Starr*	Stony Brook University
Andrew Sutherland*	Massachusetts Institute of Technology
Sho Tanimoto	Kumamoto University
Yuri Tschinkel	New York University
Anthony Varilly-Alvarado	Rice University
Nivedita Viswanathan	The University of Edinburgh
Isabel Vogt	MIT
John Voight	Dartmouth College
Laura Walton	Brown University
Yuwei Zhu	Brown University
Ziquan Zhuang	Princeton University

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *It made me realize that we have good tools to compute zeta functions. I was especially impressed by the talk of Edgar Costa in which he described how he is now able to compute zeta function of some varieties over finite fields in a rather fast manner.*
- *The poster session that I participated gave me an opportunity to talk to experts, giving me other perspectives on my current project.*
- *It was very interesting to meet and hear the talks of many colleagues from North America whom I meet less often at workshops in Europe. We had a great mix of talks with experimental and with theoretical focus.*

- *I was able to get a general overview of developments in the field, and how theoretical work closer to my research has been applied to these developments.*
- *I have been thinking about a problem theoretically for long. I have met an expert in a computational number theorist and arithmetic geometer in this workshop and had a chance to talk together. He provided me with new numerical data I could not have obtained in any places other than ICERM. This is expected to help me tremendously. I appreciate ICERM for this great opportunity. Other than this opportunity, I have had chances to talk with 6 or 7 experts in my other problems here. These discussions clarified my understanding of the problems. I also expect to have interactive collaborations with them from now on.*
- *By having talks such as Kiran's, Drew's, and Edgar's, I got to learn about the most recent developments in the computational limits of arithmetic geometry. In particular, I learned about efforts to create modern databases of arithmetic objects (for example, the LMFDB). As a mathematician at a small liberal arts college, I find that I have no problem keeping up with the latest theoretical advances in my field, but it is workshops such as these where I can learn about the experimental limits.*
- *I learned a lot about arithmetic geometry, including some computational aspects that I previously knew little about. The interdisciplinary nature of the workshop (algebraic geometry and number theory) made it particularly effective for those wanting to learn about new topics, but in a way that related to our existing expertise.*
- *In this workshop, I had a chance to get to know many people from the computational side, i.e., computing L-functions and Cox rings and it was a unique opportunity for me. Also it was a great pleasure to meet many excellent birational geometers which I have few chances to meet in other conferences.*
- *The workshop brought together two different areas together. On each sub-topic, we had multiple talks which made it easier to learn the subject. There were more theoretical-flavored talks as well as very computational (one speaker from MIT used google cloud computing to carry out 300 years worth of single core computing). Number of talks per day was no more than four, which allowed ample time for discussion.*
- *I am an algebraic geometer, but don't study birational or arithmetic geometry. So this workshop has inspired me to study these topics and their connections. The speakers were great and I talked to some of them. It was very encouraging to be here.*
- *I learned of some new techniques in computational number theory and know of the resources to look to if this comes up in my research.*

Some Workshop Participant Comments for "Describe the highlight of this workshop":

- *Talk by Costa on Hasse-Weil zeta functions of cubic fourfolds. Talk by Lehmann on accumulating sub varieties.*
- *Some of the talks, as Jordan Ellenberg's talk, were very enlightening and have helped me to understand better things that I had only partially understood so far. One of the participants has come to me with an idea for a joint project. We're now discussing its progress by email. Finally, I had the opportunity to discuss with computing experts about ideas that I have concerning two projects and believe that at least one of them will become a collaboration in a close future.*
- *The highlight of the workshop was Sutherland's talk. It was incredible how he was able to get help from Google and parallelize his computations in order to construct a database of*

genus 3 curves (specifically, how he reduced "300 year computation" to just under "10 hours").

- *The highlight of the workshop was the chance to hear from researchers who I wouldn't normally interact with at a standard algebraic geometry conference. I especially enjoyed the computation arithmetic talks.*
- *I think that the workshop as a whole has been quite a highlight. Talk-wise I particularly enjoyed the talks from Jordan Ellenberg, Brendan Hassed, Brian Lehmann, Andrew Sutherland and Ivan Cheltsov. The venue was spectacular and I really enjoyed the poster session and the reception.*
- *The lectures on computational methods in rigid cohomology and the database of L-functions / low genus curves were the most exciting for me (since this is not an area that I usually hear about).*
- *The connections between these two areas provided me with more ideas to attack my research problem. Connections with other grad students and professors. The poster session was very interactive and helpful. The location is very convenient*
- *This workshop brought two aspects -- geometry and arithmetic --- despite the title of the workshop. I liked this aspect a lot. In most other workshops only one group of people gathers, but it is much better to meet both groups in this kind of topic. Further, some computation experts are also included. This is a wonderful idea in particular from my own experience at this time. I hope to see this type of mixture of expert groups in the future ICERM workshops too. Other than this selection of experts, another highlight is to let experts work together at ICERM even outside the regular hours.*
- *As a birational geometer, I learned the basic ideas or at least some of rough pictures on Brauer groups, Manin conjectures and some related problems on rational points. Implementation of computing Cox rings was also influential to me.*
- *Many of the talks were really excellent, and I feel this was because the speakers were mindful of the fact that the audience were quite diverse in regard to their areas of expertise; thus the talks were quite expository.*
- *I am one of organizers and it was a pleasure for me to present recent advances in theoretical and computational aspects of arithmetic geometry to birational geometers, and I also enjoyed to see many recent advances in birational geometry. Our goal was to gather two camp of geometers, arithmetic and birational, and I believe that it was successful to achieve this goal.*
- *The workshop featured several talks on Manin conjecture. In one talk, the speaker described his on-going work on how we should define the so-called height, which was particularly interesting because I could see the thought process behind the progress. I also liked the lecture on the database of genus three curves: the speaker explained how various abstract/sophisticated mathematical quantities can be computed using various computer algebra system.*
- *new results on rationality problems, connections with MMP, computational aspects in studying zeta-functions, uniform bounds for torsion of abelian varieties; progress in two collaborations and one new collaboration.*
- *Listening to talks of some of the leading mathematicians of these days, learning about tools and topics which I don't currently study and meeting mathematician from different parts of the world.*

Topical Workshop 2: Frame Theory and Exponential Bases

June 4-8, 2018

Organizing Committee:
Alex Iosevich, University of Rochester
Mihalis Kolountzakis, University of Crete
Shahaf Nitzan, Georgia Tech

Workshop Description:
The problem of decomposing a function into a sum of simply structured functions is a classical area of research in Analysis. Exciting recent progress, e.g. the solution to the Kadison-Singer problem, results about exponential frames and Riesz bases in various settings, and results about orthogonal exponential bases for convex polytopes, has re-energized discussion in this area, opened new directions for study, and turned it into an even more active and fruitful area for research. The goal of this workshop is to discuss such new developments in this area. In particular, the workshop will focus on problems regarding exponential systems in weighted spaces and the Fuglede conjecture. Related settings will also be of interest, for example: (i) Systems of vectors obtained by translating, translating and modulating, or translating and dilating a single function over the line; (ii) Sampling and decomposition of functions in the finite dimensional setting; (iii) Sampling and interpolation of functions in analytic function spaces.

Participant List Topical Workshop 2

Name	**Institute**
Akram Aldroubi*	Vanderbilt University
Alexander Borichev*	Univ. Aix-Marseille
Marcin Bownik*	University of Oregon
Mihaela Dobrescu	Christopher Newport University
Keiko Dow	D'Youville College
Thomas Fallon	CUNY Graduate Center
Veronika Furst	Fort Lewis College
Rachel Greenfeld*	Bar Ilan University
Sigrid Grepstad*	Norwegian University of Science and Technology
Keaton Hamm*	Vanderbilt University
Alex Iosevich*	University of Rochester
Shujie Kang	University of Maryland
Mihalis Kolountzakis	University of Crete
Chun Kit Lai	San Francisco State University
Nir Lev	Bar-Ilan University
Elijah Liflyand*	Bar-Ilan University
Bochen Liu*	Bar-Ilan University
Romanos Malikiosis*	TU Berlin
Máté Matolcsi*	Renyi Institute
Ryan Matzke	University of Minnesota
Azita Mayeli*	CUNY
Mishko Mitkovski*	Clemson University
Shahaf Nitzan*	Georgia Tech
Michael Northington*	Georgia Institute of Technology

Alexander Olevskii*	Tel Aviv University
Jan-Fredrik Olsen*	Lund University
Joaquim Ortega-Cerdà	University of Barcelona
Vignon Oussa	Bridgewater State University
Eyvindur Palsson	Virginia Tech
Josiah Park	Georgia Tech
Stefanie Petermichl*	Universite Paul Sabatier
Armenak Petrosyan	Oak Ridge National Laboratory
Van Thang Pham	UCSD
Alexei Poltoratski*	Texas A&M University
Alexander Powell*	Vanderbilt University
Steven Senger	Missouri State University
Darrin Speegle*	Saint Louis University
David Walnut	George Mason University
Chenzhi Zhao	University of Maryland College Park

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *This was such a great opportunity to have face to face conversations with people that I don't get to see very often. Some arguments and techniques may take hours to read though, but can be explained in mere minutes in a face to face meeting.*
- *The talks helped to improve my knowledge of the subject and develop the techniques that I was not aware of it.*
- *Learned a lot of new math and had the chance to work with collaborators on projects as well. Unusual for a workshop to deliver on both fronts!*
- *No one offered source code related to their projects among the speakers, as their work was not heavily computer assisted. Speakers however presented new proof techniques looking for input from other fields of mathematics.*
- *I am less interested in experimental/computational methodologies but this workshop gave me a possibility to learn more from the lectures and discussions on certain topics I faced before only from time to time.*
- *There were many people here who are working in areas close to what I do, but that I didn't know. Several talks were given that were very interesting to me, even though I didn't realize they would be from the speaker/title. The organizers did a great job of bringing together people who hadn't necessarily worked together before, but who are working in similar areas.*

Some Workshop Participant Comments for "Describe the highlight of this workshop":

- *There were several really great breakthroughs in various problems I'm studying, which were the results of conversations between talks or at dinner. Also, I understand the main topics of the workshop more deeply.*
- *There were several fascinating talks on the subject of exponential frames. Especially I liked talks about open problems in the area given by the organizers.*
- *Fuglede's conjecture and its recent advances. Great discussions with almost all people in the world who are interested in this conjecture.*

- *The open problems sessions were generally very exciting and interesting, along with being some of the most accessible talks. I think they were one of the best parts of this conference.*
- *Highlights were the problem sessions given by the organizers, where they gave a light introduction to their topics and presented open problems.*
- *Nir Lev results on the Fuglede conjecture and the open session problems*
- *The subject of the workshop and those related are of importance in today harmonic analysis. This workshop was a unique opportunity to meet and listen to so many specialists at once. Also, there were many opportunities to figure out certain questions to do this otherwise would take much more time and efforts.*
- *I was able to meet many mathematicians I knew earlier only by papers*
- *Exposed to a new area of research.*

Topical Workshop 3: Fractional PDEs: Theory, Algorithms and Applications

June 18-22, 2018

Organizing Committee:
George Karniadakis, Brown University
Francesco Mainardi, University of Bologna
Mark Meerschaert, University of Michigan
Jie Shen, Purdue University
Hong Wang, University of South Carolina

Workshop Description:
Fractional partial differential equations (FPDEs) are emerging as a powerful tool for modeling challenging multiscale phenomena including overlapping microscopic and macroscopic scales. Compared to integer-order PDEs, the fractional order of the derivatives in FPDEs may be a function of space and time or even a distribution, opening up great opportunities for modeling and simulation of multi-physics phenomena, e.g. seamless transition from wave propagation to diffusion, or from local to non-local dynamics. In addition, data-driven fractional differential operators may be constructed to fit data from a particular experiment or specific phenomenon, including the effect of uncertainties. FPDEs lead to a paradigm shift, according to which data-driven fractional operators may be constructed to model a specific phenomenon instead of the current practice of tweaking free parameters that multiply pre-set integer-order differential operators. This workshop will cover all these areas, including (but not limited to) FPDE modeling, stochastic interpretation of FPDEs, efficient and accurate numerical solutions of FPDEs, mathematical analysis of FPDEs, and application of FPDE models.

Participant List Topical Workshop 3

Name	Institute
Harbir Antil	George Mason University
Mario Bencomo	Rice University
Animesh Biswas	Iowa State University
Andrea Bonito*	Texas A&M University
Juan Pablo Borthagaray*	University of Maryland

Evan Camrud	Iowa State University
Matthew Causley	Kettering University
Cem Celik	Dokuz Eylül University
Yanlai Chen	University of Massachusetts, Dartmouth
Zhen-Qing Chen*	University of Washington
YangQuan Chen*	UC Merced
Brian Choi	Boston University
Shue-Sum Chow	Brigham Young University
Justin Crum	University of Arizona
Marta D'Elia*	Sandia National Laboratories, NM
Beichuan Deng	Wayne State University
Weihua Deng*	Lanzhou University
Sougata Dhar	The University of Maine
Geoffrey Dillon	University of South Carolina
Siwei Duo*	University of South Carolina
Sergei Fedotov*	The University of Manchester
Nicolas Garcia Trillos*	Brown University
Roberto Garrappa*	University of Bari
Varsha Gejji	Savitribai Phule Pune University
Yiqi Gu	Purdue University
Mamikon Gulian	Brown University
Ling Guo	Shanghai Normal University
Zhaopeng Hao	Worcester Polytechnic Institute
Md Mehedi Hasan	Brown University
Derek Hollenbeck	University of California, Merced
Youngjoon Hong	University of Illinois, Chicago
Xiaozhe Hu	Tufts University
Fukeng Huang	Purdue University
Olaniyi Iyiola	Minnesota State University Moorhead
Jiahua Jiang	University of Massachusetts Dartmouth
George Karniadakis	Brown University
Nikolaos Kavallaris	Brown University
James Kelly	Michigan State University
Abdul Khaliq	Middle Tennessee State University
Dustin Kremer	University of Siegen
Svenja Lage	Heinrich-Heine Universität Düsseldorf
Changpin Li	Shanghai University
Ying Li	Missouri University of Science and Technology
Xianjuan Li	Fuzhou University/Brown University
Yulong Li	University of Wyoming
Anna Lischke	Brown University
Yuan Liu	Mississippi State University
Yuri Luchko*	Beuth Hochschule für Technik
Marcin Magdziarz*	Wrocław University of Science and Technology
Francesco Mainardi*	University of Bologna
Zhiping Mao	Brown University
Maryam Naghibolhosseini	Michigan State University
Alberto Nogueira Junior	IBM Research Brazil
Deepak Pachpatte	Dr. Babasaheb Ambedkar Marathwada University

Jeungeun Park	University of Iowa
Charles Parker	Brown University
Camelia Pop	University of Minnesota
Sivaguru Ravindran	University of Alabama in Huntsville
Enrico Scalas	University of Sussex
Peter Scheffler	University of Siegen
Jie Shen	Purdue University
Fangying Song	Brown University
Pablo Raúl Stinga	Iowa State University
Yanhui Su	Brown University
Tim Thompson	The University of Waterloo
Hong Wang	University of South Carolina
Nan Wang	Brown University
Tingting Wang	Brown University
Mahamadi Warma*	University of Puerto Rico
Bruce West*	US Army Research Office
Wuzhe Xu	University at Buffalo
Chuanju Xu*	Xiamen University
Mohsen Zayernouri*	Michigan State University
Zhongqiang Zhang	Worcester Polytechnic Institute
Kaixuan Zhang	Brown University
Yanzhi Zhang*	Missouri University of Sciences and Technology
Tinggang Zhao	Lanzhou City University
Lifei Zhao	Brown University
Yue Zhao	Brown University
Tingtao Zhou	Massachusetts Institute of Technology

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *I was able to determine the direction that many of the leaders in the field were taking and determine what the they saw as the fundamental problems going forward.*
- *Through different presentations, I have learnt a lot more on theories, computation and applications of fractional calculus.*
- *Being a graduate student that is learning the field it provides mountains of knowledge and general understanding of the limitations and current struggles of the topic. I feel I can take these methodologies and begin to use them in my applications.*
- *The talks focused on numerical methods were very interesting to me, as it is closer to my research area than the more analytical/probabilistic talks. As a numerical linear algebra person, I would have liked to have seen more talks that focused on the solution of linear systems that arise from the discretization of these problems. These linear systems are very challenging to solve, and that issue was not addressed very much.*
- *The workshop was very interesting and I learned new things in FPDE modeling and stochastic interpretation of FPDEs. Good opportunity to connect with peers.*
- *Learned a lot about: -- adaptive finite element methods for fractional partial differential equations. -- mass-conservation finite-difference methods to define and solve fractional*

partial differential equations with boundary conditions -- probabilistic theories and methods for fractional partial differential equations

- *I was not too familiar with a category of fractional problems (time-fractional problems) and I learned a lot about them. I also learned more about the connection between fractional equations and stochastic processes.*
- *Almost all of the talks during this week involved both computational methodologies as well as the theory behind them. I think this is a very common thing for applied mathematicians to do. The talks which lead to less theory are of course given by engineers/statisticians which is alright but could be improved.*
- *Discussions after session presentations were extremely clarifying on how fractional calculus can describe the complexity of many natural process and systems such as anomalous diffusion, porous media, and turbulence just to name a few. From the computational standpoint, the use of artificial neural networks (ANN) to circumvent the toughness of solving FPDEs numerically was a huge contribution to my research developments. I intend to keep in touch with some workshop speakers to further investigate the applications of ANN in the context of fractional PDEs.*
- *I am interested in FPDEs but this topic was not familiar to me. Thanks to this workshop, I learned a lot about this topic (from the basic knowledge to current interests). Via 30 mins breaks, I was able to ask some question and discuss with other researchers.*
- *Effectively add my knowledge on hierarchy matrix to reduce computational cost. On theoretical results, add my knowledge on regularity results of fractional PDEs.*
- *I learned of many new or recent results that I might have overlooked and are crucial for my research activities.*

Some Workshop Participant Comments for "Describe the highlight of this workshop":

- *Since I presented a poster on the workshop, this was one of the highlights for me. I got so many feedback and new impressions! The breaks between the talks were also very useful to get in contact with other people and talk about the topic. For me, the open discussion was another highlight.*
- *It pointed out many future directions.*
- *It has video record and panel discussion which are very helpful*
- *Insight into theories and applications of fractional calculus and the numerical analysis.*
- *The workshop exposed me to some new developments in my field of research. I could meet many old friends as well as got introduced to some new experts actively working, which in turn will help me to enhance my research. 2. I could see some new connections*
- *The highlight for me was the final talk about Hierarchical matrices.*
- *Discussions with other researchers during the break times. The talk by Nicolas Garcia-Trillos on the Bayesian formulation of fractional inverse problems and data-driven discretization of forward maps.*
- *The spectral method from Jie Shen's presentation. Application of fractional calculus in financial mathematics by Camelia Pop.*
- *Introduced the recent development in research in Fractional Partial Differential Equations. Able to Interact with the various researchers in the field. It definitely helpful in giving direction for my future research work.*

- *Discussions with other participants about connections between our research areas and potential applications of our research to physical problems.*
- *Very high level talks. Senoir experts in the field. Large variety of topics covered. Many interaction opportunities.*
- *Based on my interests which are closely related to the numerical approximations of (F)PDEs, I should mention the presentation by professor Mohsen Zayermouri and especially the open discussions captained by professor George E. Karniadakis which boiled down the essentials of the present and future developments of the FPDEs. I should also mention the introductory talk by professor Bruce West as one of my favorites.*
- *Diversity of presentations, good mix of theory and applications, good discussion.*
- *the open discussion session was the one of the most important part of the workshop. and there were a lot of high qualified talks which encourage me to continue to research at that direction. and also, meeting some of the leading people of the topic was a great experience for me. I am looking forward to see future workshops/conferences about that specific topic.*
- *From my career point of view, I think the most important aspect of the workshop was to present my work to other researchers in the area. I also liked the fact that topics covered different aspects of fractional pdes (modeling, analysis, related probability problems, numerical methods).*
- *All talks were interesting, but I particularly appreciated the following ones as they gave me immediate direct ideas for further research: Fractional Dynamics of Individuals in Complex Networks - Bruce West, US Army Research Office Anomalous cumulative inertia and transport on network - Sergei Fedotov, The University of Manchester Fractional time equations and probabilistic representation - Zhen-Qing Chen, University of Washington The obstacle problem for the fractional Laplacian with drift - Camelia Pop, University of Minnesota Numerical methods for non-standard fractional operators in the simulation of dielectric materials - Roberto Garrappa, University of Bari, Italy Non-symmetric fractional operators as special cases of nonlocal convection-diffusion operators- analysis and applications. - Marta D'Elia, Sandia National Laboratories Maximum principle for the fractional diffusion-wave equations and its applications - Yuri Luchko, Technical University of Applied Sciences Berlin Modeling of fractional dynamics using Levy walks - recent advances - Marcin Magdziarz, Wroclaw University of Science and Technology, Poland*
- *Excellent selection of speakers. Important and interesting topic. Wonderful organization. Very kind staff. Nice place.*
- *The possibility of future collaboration is the most important to me.*
- *Several talks were extremely interesting. I also met a few young mathematicians whom I talked with about my current on-going projects. We are likely to establish some further collaborations in the next months. This is very exciting!*

Topical Workshop 4: Computational Aspects of Time Dependent Electromagnetic Wave Problems in Complex Materials

June 25-29, 2018

Organizing Committee:

Vrushali Bokil, Oregon State University
Yingda Cheng, Michigan State University
Susan Hagness, University of Wisconsin
Fengyan Li, Rensselaer Polytechinic Institute
Fernando Teixeira, Ohio State University
Shan Zhao, University of Alabama

Workshop Description:
Forward simulations of the propagation and scattering of transient electromagnetic (EM) waves in complex media are important in a variety of applications, such as radar, environmental and medical imaging, noninvasive detection of cancerous tumors, design of engineered composites such as metamaterials, communication and computation, and global climate assessment, among others. These applications involve multiple spatial and temporal scales, complex geometries, spatial and temporal heterogeneities, and stochastic effects at small scales.

Biological tissues are complex media with inhomogeneous and frequency dependent (dispersive) properties. Analyses of EM wave interactions with biological media is fundamental in many medical applications, such as noninvasive diagnosis techniques, and for advancing the quality of medical imaging in general. Characterization of EM wave interaction with natural media is of great importance for environmental remote sensing and global climate assessment. In recent years, there has been an upsurge in the design and development of new materials with tailored EM properties under the conceptual umbrella of metamaterials. These include, but are not limited to, ferroelectric materials, EM or photonic bandgap materials, low-loss magnetodielectrics, left-handed or double-negative media, low-k dielectrics, and surface plasmon devices. Engineered metamaterials have shown great promise as building blocks for devices with unique EM responses, from the microwave to the optical frequency range.

The applications above involve EM wave propagation in complex materials, and require solving the time-domain Maxwell's equations in the materials considered. In most cases, due to the presence of heterogeneities and complex geometries, it is impossible to solve Maxwell's equations exactly. Thus, the development and analysis of efficient numerical methods that are accurate, consistent, and stable is important for constructing reliable prediction tools for simulating EM waves in complex materials.

This workshop aims to bring together different scientific communities, including mathematicians, engineers, physicists, software developers and other relevant people, to disseminate current progress in their areas and develop potential collaborations to address challenges involved in the solution of the time-domain Maxwell's equations in complex materials through computational and experimental research with the broad aim of addressing and solving real-world applications.

Participant List Topical Workshop 4

Name	**Institute**
Reza Abedi*	University of Tennessee Space Institute
Asad Anees	Technology University Clausthal Zellerfeld
Daniel Appelö*	University of Colorado Boulder

Dinshaw Balsara*	Notre Dame
Mario Bencomo	Rice University
Shubhendu Bhardwaj*	Florida International University
Vrushali Bokil	Oregon State University
Camille Carvalho*	University of California, Merced
Matthew Causley*	Kettering University
Yanlai Chen*	University of Massachusetts, Dartmouth
Zheng Chen	Oak Ridge National Laboratory
Yingda Cheng*	Michigan State University
Sehun Chun	Yonsei University
Luis Manuel Díaz Angulo*	University of Granada
Julio de Lima Nicolini	Ohio State University
Bo Dong	University of Massachusetts Dartmouth
Vladimir Druskin*	Druskin Algorithms
Marina Fischer	Heinrich-Heine-University
Guosheng Fu	Brown University
Nathan Gibson*	Oregon State University
Zachary Grant	University of Massachusetts Dartmouth
Samuel Groth	Massachusetts Institute of Technology
Tom Hagstrom*	Southern Methodist University
Mingyu Hu	University of Colorado, Boulder
Sébastien Imperiale*	INRIA, Paris-Saclay, Université, France
Baasansuren Jadamba	Rochester Institute of Technology
Jiahua Jiang	University of Massachusetts Dartmouth
Steven Johnson*	Massachusetts Institute of Technology
Maryna Kachanovska*	INRIA
Erin Kiley	Massachusetts College of Liberal Arts
Sandeep Koranne	Oregon State University
Fengyan Li	Rensselaer Polytechinic Institute
Jichun Li*	University of Nevada Las Vegas
Dong Liang*	York University
Jinjie Liu*	Delaware State University
Lina Ma	Trinity College
Duncan McGregor*	Sandia National Laboratories
Misun Min*	Argonne National Laboratory
Dong-Yeop Na*	The Ohio State University
Prashanth Nadukandi	The University of Manchester
Minah Oh	James Madison University
Derek Olson*	Rensselaer Polytechnic Institute
Zhichao Peng	Rensselaer Polytechnic Institute
Francesca Rapetti*	University of Nice Sophia Antipolis
Homer Reid*	Simpetus
Puttha Sakkaplangkul	Michigan State University
Costas Sarris*	University of Toronto
Claire Scheid*	University of Nice
Eric Stachura	Haverford College
Andre Strong	Delaware State University
Alexandra Tambova	Skolkovo Institute of Science and Technology
Arne Van Londersele*	Ghent University

Kening Wang	University of North Florida
Xinyue Yu	brown university
Mikhail Zaslavsky	Schlumberger
Shan Zhao	University of Alabama
Feng Zheng*	Xiamen University
Jörn Zimmerling	TU Delft

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *This workshop provides me with a broad idea what people been working on and the numerical methods that researchers use. Some reduction methods and acceleration methods intrigued me with some ideas in the projects I'm working on right now. Really helpful.*
- *The workshop had a nice range of talks on wave phenomena. Although I think the "transient wave" goal of the workshop was slightly restrictive. I think a more general wave theme (including frequency domain) would have been preferable. Of particular note was the talk by Steve Johnson concerning adjoint methods for optimization.*
- *I think this workshop was a fantastic mix of all methodologies.*
- *I learned a lot from this workshop; in fact, I have started working on a new project which I would not have known about without attending this workshop. Being an analyst, I learned a lot of the importance of numerical analysis, and I hope to employ more numerics in my future work.*
- *The workshop included a balanced list of high-quality researchers and experts advancing theoretical investigations as well as numerical computations. The presentations covered many current areas of development and ICERM provided an excellent space and atmosphere for collaborations.*
- *It helped me to explore more computational areas, with different interesting computational problems and techniques.*
- *From Steve Johnson's talk I learnt about Anderson Acceleration. I also met several leading experts in FDTD for non-linear material which will be very useful. We are already starting a collaborative research program, and will acknowledge ICERM in it once we publish or present.*
- *In fact, I didn't have an exact knowledge on discontinuous Galerkin method, but through this workshop, I was able to understand more in detail about it.*
- *The talks given at this workshop widened the scope of my interests within computational wave propagation, and introduced me to several potential collaborators who are doing problems similar to mine, using different numerical methods.*

Some Workshop Participant Comments for "Describe the highlight of this workshop":

- *This workshop gave me to extend research connections and very useful to get advanced technology from the computational electromagnetic community -- I could consider the ideas from speakers' talks and had lots of discussions involving exchanging ongoing papers with others.*
- *The feedback I received after my presentation was extremely valuable.*

- *Presentation was live streamed!*
- *I am extremely fond of the group lunch for Women in scientific computing. It is a great way to expand my network.*
- *The WINAsc lunch. It demonstrated that in addition to fantastic science this workshop also honored diversity in this area.*
- *Definitely the highlight was developing a new research project, which would have not happened without this fantastic workshop and the great talks that were there.*
- *I really appreciated the presence of many researchers who were women at various stages of their career at the workshop and the embedded WINASc event. It made me more comfortable interacting with others (not just with other women but with men as well) and exchanging ideas. Overall, the workshop had a very diverse group of participants that also included many researchers from countries other than the USA. I sincerely appreciate ICERM's and the workshop organizers' efforts to have a diverse mixture of speakers (in many ways) at the workshop.*
- *The workshop was a good mix of older and more modern style computational methods for electro magnetic. I particularly enjoyed the gender, ethnic and age diversity of the participants. The atmosphere created by the organizers was very relaxed and open.*
- *I work in a different area of mathematics and my recent research developments in principle have application in the topic of this workshop. I came here just to explore that possibility and connect to scientists working in this area. This objective was met.*
- *This workshop was highly concentrated on computational science so that I was able to have talks with others more from technical aspects and share each experience with them in terms of solving difficulties in doing research. A lot of useful talks and posters were interesting for me as well. Especially, panel session was also meaningful time for me to hear personal opinions on future directions of computational science and so on. Overall, it was great for me and hopefully, I would like to participate in this workshop later. And also would like to appreciate organizers of ICERM workshop and their supports.*
- *An opportunity to disseminate my work and check how relevant it is for the community. I extract many lessons from other colleagues' methodologies and problematics.*
- *Seeing Dr. Steven Johnson, Dr. Sarris, and Dr. present their work.*
- *The highlight of this workshop was the opportunity to speak with people who are active in computational wave problems. I'm trying to restart my research, and the informal networking sessions, including the Women in Numerical and Scientific Computing lunch, were valuable in introducing me to potential collaborators.*
- *Diversity in participants: from both academic and industry; from math, physics, and engineering; from world wide.*

Topical Workshop 5: SageDays@ICERM: Combinatorics and Representation Theory

July 23-27, 2018

Organizing Committee:
Gabriel Feinberg, Washington College
Darij Grinberg, University of Minnesota
Ben Salisbury, Central Michigan University
Travis Scrimshaw, University of Queensland

Workshop Description:
SageMath (sometimes Sage for short) is an open-source, general purpose mathematical software based on the Python programming language. It was created in 2005 by William Stein as a viable alternative to commercial software with an active and established community. SageMath has a broad library of functions useful to mathematicians in many fields, including combinatorics and representation theory. The welcoming and engaged community of users and contributors helps to create an environment of collaboration in both software development and mathematical research, leading to SageMath being cited in over 300 papers.

The study of the representation theories of certain algebras (e.g., Lie algebras, Hecke algebras, Khovanov–Lauda–Rouquier (KLR) algebras, quantum groups, etc.) also amounts to understanding the associated combinatorics. This has exposed deep connections between the associated representation theory and other areas of mathematics and physics. However, there are still areas in which development is urgently needed; for example, representation theory of Lie superalgebras, Borcherds (or generalized Kac–Moody) algebras and their representations, KLR algebras, etc.

The primary goal of this workshop is to expand and improve the combinatorics, algebra, and representation theory in SageMath by increasing the user base and encouraging users to contribute their own code. Thus, similar to previous SageDays, this workshop is open to all levels of experience with SageMath: from those who want to discover SageMath to experienced developers.

The workshop will partially consist of talks, presentations, and active demonstrations on some of the relevant mathematical topics, using SageMath, and coding within SageMath. The rest of the workshop will be devoted to coding sprints, time where people can work (either individually or in groups) on code or applying SageMath. The nature of the talks on the underlying mathematics will vary from introductory to specialized and will be aimed at the interests of those participating. Similarly, the presentations on SageMath will include introductory tutorials and extend to development in SageMath.

Participant List Topical Workshop 5

Name	Institute
Amaechi Abuah	Swarthmore College
Farid Aliniaeifard	CU Boulder
Ola Amara Omari*	Bar-Ilan University
Jeffrey Ayers	University of Massachusetts Amherst
Suman Balasubramanian	DePauw University
Rekha Biswal	Universite Laval
Jon Brundan*	University of Oregon
Daniel Bump*	Stanford University
Man-Wai Cheung	Harvard University
Seung-Il Choi	Seoul National University
Jackson Criswell	Central Michigan University
Aram Dermenjian	UQAM
Kevin Dilks	North Dakota State University

Anne Dranowski	University of Toronto
Elizabeth Drellich	Swarthmore College
David Einstein	Optimal Algorithmics
Gabriel Feinberg	Washington College
Christian Gaetz	MIT
Darij Grinberg	University of Minnesota
Emily Gunawan*	University of Connecticut
Ezra Halleck	New York College of Technology (CUNY)
Adam Hausknecht	UMass Dartmouth
Russell Hensel	Self
Dylan Heuer	North Dakota State University
Mee Seong Im*	US Military Academy
Ilseung Jang	Seoul National University
Elizabeth Jurisich*	University of Charleston
Elizabeth Kelley	University of Minnesota
Gabrielle Kerbel	Mount Holyoke College
Sandra Kingan	Brooklyn College, CUNY
Robert Kingan	Bloomberg, LP
O'Neill Kingston	Iowa State University
Aaron Lauve*	Loyola University, Chicago
Kyu-Hwan Lee*	University of Connecticut
Sang-Gu Lee	Sungkyunkwan University
Mingyan Lin	University of Illinois at Urbana-Champaign
Olya Mandelshtam	Brown University
Eric Marberg	The Hong Kong University of Science and Technology
Jeremy Meza	UC Berkeley
Hugo Mlodecki	Université Paris-Sud
Dinakar Muthiah*	University of Massachusetts - Amherst
Can Ozan Oguz	University of Southern California
Brendan Pawlowski	University of Michigan
Oliver Pechenik	University of Michigan
Matthew Plante	University of Connecticut
Wencin Poh	University of California, Davis
Viviane Pons*	Université Paris-Sud
Anna Puskás*	University of Massachusetts, Amherst
Biswajit Ransingh	Institute of Mathematical Sciences, Chennai
Tom Roby*	University of Connecticut
Ben Salisbury*	Central Michigan University
Matheau Santana-Gijzen	University of Massachusetts, Amherst
Jo√£o Santos	CMUC, Center for Mathematics, University of Coimbra
Mary Schaps*	Bar-Ilan University
Anne Schilling*	UC Davis
Travis Scrimshaw	University of Queensland
Mark Shimozono*	Virginia Tech
Jessica Striker*	North Dakota State University
Sheila Sundaram	Pierrepont School
Nicolas Thiéry*	Université Paris-Sud
Hugh Thomas*	Université Québec a Montréal
Vít Tucek	University of Zagreb

Michael Walter	University of Amsterdam
Daniel Weber	University of Massachusetts Amherst
Bruce Westbury	None
Nathan Williams*	University of Texas at Dallas
Charles Yang	Swarthmore College
Meesue Yoo	Sungkyunkwan University

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *Wow, I learned so much. It was a great week. I am now able to do software development for Sage, which was definitely not the case before this conference. I also learned a lot of mathematics. In particular, I'm now much more comfortable with web basis and with representations of queer superalgebras.*
- *Usually SageDays have more time to work on code together. These SageDays had a lot of talks and much less time for coding. It might have been good to spread the talks around a little more.*
- *There were many opportunities to learn about such methodologies and developments, but I did feel that as someone newer to Sage, and particularly Sage development, I might have benefited from more tutorials and fewer talks. That isn't really a complaint, though, as the easiest solution from my perspective is simply to attend more such workshops!*
- *The things I have learned at Sage Days @ ICERM will help me create better, and higher-level code to support my research with experiments. I have a much better understanding of the structure and development of Sage as well, which will make it easier to contribute my code in the future.*
- *Learned more about how Sage operates in the combinatorial realm and how to develop in it.*
- *It was great to have such a strong collection of active and diverse researchers presenting their current topics of research and how computational techniques have aided their development.*
- *In both this SageDays and the previous one which I attended at ICERM I learned a great deal about the resources available for experimental mathematics in the field. I thought that the talks were all on a high level, and most of them were at least indirectly relevant to my topics of research. I also made contact with people who could help me with my programming problems.*
- *ICERM brought together mathematicians and I took advantage of this by talking with several of them about their research and mine. This was an unprecedented learning opportunity. Of course I also took advantage of the sage gurus to learn about sage. Altogether this was probably the most effective and productive conference I have attended so far in my math career. More please! Now that we know how to use sage, a series of specialized workshops on developing/improving specific functionality would be awesome! Remotely if need be. The conference basically accomplished this by making public a project pool.*

- *I learnt a lot about using the SageMath system (which I had actually never used before). The expert organizers were very generous with their time in answering my elementary questions. I think it will be very valuable for my future research to have this new skill.*
- *I learned of some very interesting developments, including a graphical interface for n-categories, which could be potentially adapted to apply to algebraic knot theory and categorification in representation theory.*
- *I had discussions with sage experts on how I should proceed with my project. As a result I now have a clear idea of what I need to do. I had an informal discussion where a question I asked led to a very intriguing result. I had several other discussions which were more networking in that I learnt about other people's projects.*
- *I feel like the design of the week was not ideal. The thing that brings us together is a common interest in Sage, but people's talks were largely conventional math talks. Since our mathematical interests are actually quite diverse, I didn't find it easy to get much out of most of the talks.*
- *Before coming to ICERM, everything that I knew about programming in SageMath was self-taught and so my code was somewhat haphazard. The 'tutorials'/'classes' taught by some participants were very helpful in learning how to write more stylistically consistent code, so my code will actually be appropriate for incorporation into SageMath. I also learned a great deal about the process of developing for Sage, using git, and pushing to the trac server.*
- *1. I learned how to download and build the developer's version of SageMath. 2. I learned the basics of how to contribute to SageMath's documentation and code. 3. I learned about SageMath's switch to ThreeJS for its graphics which will likely improve SageMath's animation features and make it possible for me to implement certain features that I need for a calculus III and/or an undergraduate course on differential geometry.*

Some Workshop Participant Comments for "Describe the highlight of this workshop":

- *the opportunity to work on SAGE code that was relevant to my research with other experts in the field, thus saving me dozens of hours of figuring it out on my own, and giving me important new ideas.*
- *Learning about the experimental power of SAGE, and connecting with people who are actively working in a rapidly evolving area of research*
- *The highlight was the superb and thought provoking presentation from Nicolas Thierry about the SageMath view of mathematics.*
- *Highlight was free time towards the end of the week when I was able to help people with projects they had been working on, and collaborate with colleagues on figuring out some new features which needed to be contributed to SAGE.*
- *The large number of participants with great amount of diversity.*
- *Having multiple people overhear some casual discussion of symplectic tableaux and come over to introduce themselves and quickly convert it into planning a coding project on the topic!*
- *The banquet and the tutorial sessions run by Nicolas Thiery and Ben Salisbury.*
- *At breakfast on Friday morning, I had a discussion with Daniel Bump and discovered that he is developing an interest in the Kashiwara crystals on which I work. I am also about to try to compute Kashiwara crystals for one type of superalgebra.*

- *Learning that one cannot manipulate the quotient of a path algebra without specifying a normal form.*
- *1.The ability to interact with others with experience in contributing to SageMath (Travis, Ben and Nicolas) including given by Nicolas about the overall class structure of SageMath. 2. Also, learning how others are using SageMath for their research.*
- *Seeing so many new people becoming interested and active in SageMath.*
- *The talks were of high quality. I had several really interesting scientific conversations with participants.*
- *The highlight of my visit to ICERM was definitely being able to collaborate with another mathematician to update code that I wanted to use in my research. Learning how to use git, pull from the trac server, and push to update a ticket was extremely exciting, since I have other code that I would like to contribute.*
- *I think the highlight is a tie between two separate aspects of my week here. One highlight is having long conversations with a couple of colleagues about their recent work (which is very relevant to my own research, and will likely influence its future direction). The other highlight is learning about the Category-Parent-Element design pattern in Sage.*
- *Participants were actively helping me solve the issues I ran into during coding, using sage, installing sage...etc. For the first time I encountered a large community that is behind the Sage, writing the code I have been using. Now I can contribute and become a part of the community as well. I met other people with similar research interests, and we discussed how sage can be useful in solving these issues.*

Topical Workshop 6: Advances in PDEs: Theory, Computation and Application to CFD

August 20-24, 2018

Organizing Committee:
Alina Chertock, North Carolina State University
Adi Ditkowski, Tel Aviv University
Anne Gelb, Dartmouth College
Johnny Guzman, Brown University
Jan Hesthaven, Ecole Polytechnique Federale de Lausanne
Yvon Maday, University Pierre and Marie Curie
Jennifer Ryan, University of East Anglia and Heinrich Heine University

Workshop Description:
Partial differential equations (PDEs) have long played crucial roles in the field of fluid dynamics. These PDE models, including Euler and Navier-Stokes equations for incompressible and compressible flows, kinetic equations for rarefied flows, and equations for more complex flows such as magneto-hydrodynamics flows, have motivated numerous studies from the theory of PDEs to the design and analysis of computational algorithms, and their implementation and application in computational fluid dynamics (CFD). This discipline is continually and dynamically evolving, constantly bringing forward new results in PDE theory, computation, and application to CFD, and also setting up the ground for generalizations to other related applications including electro-magnetics, fluid-structure interactions, cosmology, and computational electronics.

The aim of this workshop is to review the recent progress in the type of PDEs arising from fluid dynamics and other related physical areas, in terms of their theory, computation, and applications. The invited speakers include PDE analysts, applied and computational mathematicians, and engineers. Many of the invited speakers have made fundamental contributions to the development of PDE numerical methods and mathematical analysis as well as cutting edge applications. In harmony with ICERM's mission, the most significant aspect of this workshop is cutting-edge computational mathematics, and reinforcing the critical role played by computation in the mathematical and experimental aspects of fluid dynamics.

This workshop aims to showcase recent advances in the theory and computation of PDEs with applications in CFD. It is thus an excellent vehicle to commemorate Professor Saul Abarbanel, who has made fundamental contributions to fluid dynamics and PDEs, especially in their computation and application to CFD. To honor his memory, this workshop will focus on recent developments in the field, highlighting the exchange of current research ideas and setting the stage for future research.

Participant List Topical Workshop 6

Name	**Institute**
Azhar Alhammali	Oregon State University
Bahador Bahmani	the University of Tennessee
Yuanxun Bao	University of Texas, Austin
Abhijit Biswas	Temple University
Tan Bui-Thanh	University of Texas at Austin
Ernesto Caceres	Brown University
Xiaofeng Cai	University of Delaware
Duo Cao	Purdue University
Mark Carpenter*	NASA Langley Research Center
Yanlai Chen	University of Massachusetts, Dartmouth
Anqi Chen	Michigan State University
Alina Chertock*	North Carolina State University
Alexandre Chorin*	University of California, Berkeley
Stavros Christofi	Western Connecticut State University
Nattaporn Chuenjarern	Michigan Technological University
Sidafa Conde	Sandia National Laboratories
Constantine Dafermos*	Brown University
Mingchang Ding	University of Delaware
Adi Ditkowski*	Tel Aviv University
Julia Docampo Sanchez	MIT
Wai-Sun Don*	Ocean University of China
Bo Dong	University of Massachusetts Dartmouth
Rebecca Durst	Brown University
Fariba Fahroo	DARPA
Dalia Fishelov*	Afeka-Tel Aviv Academic College of Engineering
Guosheng Fu	Brown University
Lin Fu	Stanford University
Anne Gelb*	Dartmouth College
Debojyoti Ghosh	Lawrence Livermore National Laboratory
Jan Giesselmann	RWTH Aachen University

Jan Glaubitz	TU Braunschweig
Sigal Gottlieb*	University of Massachusetts Dartmouth
Wei Guo	Texas Tech University
Bertil Gustafsson*	Uppsala University
Johnny Guzman*	Brown University
Fanchen He	University of Michigan
Alfa Heryudono	University of Massachusetts, Dartmouth
Jan Hesthaven*	Ecole Polytechnique Federale de Lausanne
Fumi Honda	Brown University
Xiao Hou	University of Wisconsin - Madison
Kai Huang	Michigan State University
Xiaokai Huo	King Abdullah University of Science and Technology
Leah Isherwood	University of Massachusetts - Dartmouth
Olaniyi Iyiola	Minnesota State University Moorhead
Ameya Jagtap	Tata Institute of Fundamental Research
Lee Jameson	National Science Foundation
Antony Jameson*	Stanford University
Jaber Javanshir Hasbestan	University of Pittsburgh
Jiahua Jiang	Virginia Tech
Shuai Jiang	Brown University
Shinhoo Kang	University of Texas at Austin
George Karniadakis*	Brown University
Mukesh Kumar	College of Charleston
Rakesh Kumar	TIFR Centre for Applicable Mathematics
Alexander Kurganov*	Southern University of Science and Technology, Tulane University
Yoonsang Lee	Dartmouth College
Xiaozhou Li	University of Electronic Science and Technology of China
Longfei Li	University of Louisiana at Lafayette
Hao Li	Purdue University
Xiaole LI	The Ohio State University
Yunzhang Li	Brown University
Antonios Liakopoulos	Brown University
Jinguo Lian	UMass
Jessica Libertini*	Virginia Military Institute
Yvon Maday*	University Pierre and Marie Curie
Leonardo Marazzi	Savannah College of Art and Design
Romit Maulik	Computational Fluid Dynamics Laboratory
Zachary Miksis	University of Notre Dame
Misun Min*	Argonne National Laboratory
Sriramkrishnan Muralikrishnan	The University of Texas at Austin
Kit Newton	University of Wisconsin-Madison
Thuong Nguyen	University of Utah
Jan Nordstrom	Link√∂ping University
Laura Petto	Dartmouth College
Abdul Rahimyar	Western Connecticut State University
Philip Roe*	University of Michigan
Jennifer Ryan*	University of East Anglia and Heinrich Heine University
Amir Sagiv	Tel Aviv University
Leonardo Scandurra	Heinrich-Heine-Universität Düsseldorf

Choah Shin	Oregon State University
Michael Shoushani	Western Connecticut State University
Chi-Wang Shu*	Brown University
Paramjeet Singh	Thapar Institute of Engineering and Technology
Bedrich Sousedik	University of Maryland, Baltimore County
Varsha Srivastava	Indian Institute of Technology Delhi, India
Walter Strauss*	Brown University
Eitan Tadmor*	University of Maryland
Qi Tang	Rensselaer Polytechinic Institute
Jing Tian	Towson University
Eric Tovar	Texas A&M University
Semyon Tsynkov*	North Carolina State University
Eli Turkel*	Tel Aviv University
Xiao Wen	Ohio State University
Ziyao Xu	Michigan Technological University
Yang Yang	Michigan Technological University
Helen Yee	NASA Ames Research Center
Minglang Yin	Brown University
Zhiyuan Zhang	Brown University
Xu Zhang	Mississippi State University
Feng Zheng	Xiamen University
Fangyao Zhu	Michigan technological university

*Workshop speaker

Some Workshop Participant Comments for "Please describe how ICERM has (or has not) added to your knowledge of experimental/computational methodologies and/or theoretical developments within this topic.":

- *The program was nicely diversified, with talks that focused on theory, applications, and computation.*
- *ICERM gave us many lectures about DG, Large Time Steps for RK and Navier-Stokes Eq. This very helps to me.*
- *I particularly enjoyed the overview of Saul Abarbanel's contributions to the field of applied and computational math, especially with regards to PDEs and fluids. I also liked seeing the theoretical side of algorithmic development for PDEs, which is not something I feel is focused on too much at the conferences I usually attend.*
- *The recent development of the nonlinear entropy stable numerical schemes, uncertainly qualification, and summation by part schemes are of paramount important to my current research. The talks by the experts in these fields are very enlightening and have direct impact in pushing my research to a new level.*
- *I am very excited to hear all the talks related to Computational Fluid Dynamics and know what is the most update research topics in the area.*
- *The speakers presented a wide range of cutting-edge developments in scientific computations and numerical analysis. The long (45min) talks enabled the speakers to give detailed presentations and the long time for questions, as well as the breaks, encouraged discussions, and potential collaboration between the participants.*
- *There is good diversity of topics in this field. It's a good chance to know about the research works not only of senior researchers but also other graduate students. What's*

more, learning about the applications of computational work is also a very appreciated experience.

- *The participation of all star team of researchers made it extremely valuable for the rookies We also could have a chance to meet and speak to our role models*
- *During this workshop I met many experts from the academia/industry. Interaction with them was very good which not only increases my level of understanding of the subject but also created some opportunity where I can work with them. Thank you ICERM for giving me this opportunity.*
- *It is a great opportunity to meet experts across the field and the way that it is organizes allows for having plenty opportunities for discussing scientific research. I think that the quality of the speakers was phenomenal and very inspiring and everyone (speakers and non speakers) was keen on discussing topics further and beyond the talks. I would also like to add that the staff at ICERM are super helpful and welcoming.*
- *Due to the applied nature of my background - it was eye-opening to observe the wealth of research underway in the theoretical aspect of numerical methods.*

Some Workshop Participant Comments for "Describe the highlight of this workshop":

- *It was an excellent opportunity for me to learn from speakers and exchange experiences with other participants and speakers. The workshop was well-structured, comprehensive, rich in content and useful for implementing the shared ideas. The workshop was great in terms of content and methodology. Individual lectures were informative and well organized. I would highly recommend any future workshop organized by ICERM to my colleagues and friends. For future, I recommend that more such workshops should be organized by ICERM as such workshops provide an excellent opportunity to learn from and exchange experiences with others.*
- *It is very helpful to keep in touch with both young and established scholars. In particular, I feel ICERM provides a great opportunity for young scholars to communicate with each other.*
- *The talks by Maday and by Jameson.*
- *This workshop was an excellent vehicle to commemorate Professor Saul Abarbanel. It aims to showcase recent advances in the theory and computation of PDEs with applications in CFD.*
- *Presentation by Eitan Tadmor on entropy stability*
- *Highlight? The talks and individual consultations are all highlight to me personally. The talks are very exciting and new. I enjoyed every minutes of the whole conference.*
- *I think there was a good balance of theory and computations (even HPC). I did like talks mentioning experiments with machine learning (Profs. Karniadakis's and Hesthaven's talks), and I actually liked slightly off-topic but (refreshing and) very interesting talk of Prof. Maday about molecular simulations.*
- *Just having the chance to interact with top researchers and meet old friends*
- *It was a wonderful workshop, from which I could learn about important topics related to my research. It strengthened current scientific connections and created several new. The atmosphere was very friendly and everything was held in a professional manner.*
- *There are so many leading experts giving talks which is rare to find in other conferences.*
- *Being surrounded by a community of experts in the field in an intimate workshop setting.*

- *The poster session and meeting new, junior researchers.*
- *The presence of many other women in my field with whom I had a lot in common.*
- *While almost all the presentations were excellent, some of them were outstanding. This workshop brought together extraordinary people which came especially for this meeting, in particular, Bertil Gustafsson,*
- *Inspiring work by some people, such as Chi-wang Shu, Jan Hesthaven, etc. ICERM did a great job to help people to discuss ideas and build connections. Very helpful for people at beginning of their career.*
- *Definitely something I can put in my CV. Know more about senior researchers in this field.*
- *The extended coffee break time allowed between sessions was very helpful to have an opportunity to talk to everyone. I am junior in academia and I found it very easy to talk with the speakers about their work and actually discuss things related to my research. This workshop has been great to stimulate my work and for wanting to contribute towards this community.*
- *Dr. Karniadakis' talk on fractional derivatives. It has potentially opened up a new long-term research direction for me.*
- *I saw a talk that made me think about how I could use a new method in my own research. I was able to make a connection for future collaboration.*

Topical Workshop 7: Celebrating 75 Years of Mathematics of Computation

November 1-3, 2018

Organizing Committee:
Susanne Brenner, Louisiana State University
Igor Shparlinski, The University of New South Wales
Chi-Wang Shu, Brown University
Daniel Szyld, Temple University

Workshop Description:
This symposium will highlight the progress in the mathematics of computation over the last few decades. The invited lectures will present historical surveys of important areas or overviews of topics of high current interest. Together they will provide a panoramic view of the most significant achievements in the past quarter century in computational mathematics and also the most important current trends.

The year 2018 marks the 75th anniversary of the founding of Mathematics of Computation, one of the four primary research journals of the American Mathematical Society and the oldest research journal devoted to computational mathematics. This symposium will commemorate the event with invited lectures and poster presentations that reflect the spectrum of research covered by Mathematics of Computation at this juncture of its illustrious history.

The first day of the symposium (November 1) is devoted to the discrete topics and the other two days (November 2-3) are devoted to continuous topics. A reception will be held on November 1.

All participants will have the opportunity to present their work with posters. Young researchers are especially encouraged to participate.

Participant List Topical Workshop 7

Name	Institute
James Adler	Tufts University
Douglas Arnold*	University of Minnesota
Andrea Arnold	Worcester Polytechnic Institute
Asher Auel	Yale University
Iman Bahmani Jafarloo	Politecnico di Torino
Olga Balkanova	University of Gothenburg
Yuanxun Bao	University of Texas, Austin
Andrea Bertozzi*	UCLA
Fleurianne Bertrand	Humboldt Universität zu Berlin
Daniele Boffi	University of Pavia
Wietse Boon	University of Stuttgart
Susanne Brenner	Louisiana State University
Jolene Britton	University of California, Riverside
Ana Budiša	University of Bergen
Vladislav Bukshtynov	Florida Institute of Technology
Lucia Carichino	WPI
Sean Carney	University of Texas at Austin
Aycil Cesmelioglu	Oakland University
Faycal Chaouqui	Temple University
Zheng Chen	University of Massachusetts Dartmouth
Jiajie Chen	University of Delaware
Alina Chertock	North Carolina State University
Stavros Christofi	Western Connecticut State University
Ronald Cools	KU Leuven
Gary Crosby	University of North Carolina Charlotte
Wolfgang Dahmen*	University of South Carolina
Bruno Despres	Sorbonne university
Papri Dey	IIT Bombay
Amanda Diegel	Mississippi State University
Mingchang Ding	University of Delaware
Bo Dong	University of Massachusetts Dartmouth
Qiang Du*	Columbia University
Bettina Eick*	Technische Universität Braunschweig
Howard Elman	University of Maryland
Bjorn Engquist*	UT Austin
Siamak Faal	WPI
Richard Falk	Rutgers University
Christina Frederick	New Jersey Institute of Technology
Dmitry Frolenkov	Steklov Mathematical institute of RAS
Jose Garay	Louisiana State University
Ajeet Gary	University of Maryland
S√¥nia Gomes	Universidade Estadual de Campinas
Yiqi Gu	Purdue University

Ruchi Guo	Virginia Tech
Johnny Guzman	Brown University
Nguyenho Ho	Bridgewater State University
Xiaozhe Hu	Tufts University
Juntao Huang	Michigan State University
Evelyne Hubert	INRIA
Milen Ivanov	Brown University
Michael Jacobson Jr.	University of Calgary
SeongHee Jeong	Louisiana State University
Shuai Jiang	Brown University
Ellya Kawecki	Louisiana State University
Abdul Khaliq	Middle Tennessee State University
Frances Kuo*	University of New South Wales
Alexander Kurganov	Southern University of Science and Technology, Tulane
Yoonsang Lee	Dartmouth College
Seulip Lee	UC IRVINE
Dmitriy Leykekhman	University of Connecticut
Xingjie Li	University of North Carolina at Charlotte
Fengyan Li	Rensselaer Polytechinic Institute
Jichun Li	University of Nevada Las Vegas
Yukun Li	The Ohio State University
Linjin Li	University of Delaware
Longfei Li	University of Louisiana at Lafayette
Yunzhang Li	Brown University
Yuan Liu	Mississippi State U
Sijing Liu	Louisiana State University
Yong Liu	USTC
Tyson Loudon	University of Minnesota-Twin Cities
Gunter Malle*	Technische Universit√§t Kaiserslautern
Mutaz Mohammad	Zayed University
Peter Monk*	University of Delaware
Michael Mossinghoff	Davidson College
Mallikarjunaiah Muddamallappa	Texas A&M University-Corpus Christi
Michael Neilan	University of Pittsburgh
Ricardo Nochetto*	University of Maryland
Adam Oberman*	McGill University
Andrew Odlyzko*	University of Minnesota
Sarah Olson	Worcester Polytechnic Institute
Tomas Pajdla	Czech Technical University in Prague
Christian Parkinson	University of California Los Angeles
Carl Pomerance*	Dartmouth College
Abdul Rahimyar	Western Connecticut State University
Kristian Ranestad	University of Oslo
Caylah Retz	University of North Carolina at Charlotte
Francois-Henry Rouet	Livermore Software Technology Corporation
Yousef Saad*	University of Minnesota
Najmeh Salehi	Temple University
Ruchi Sandilya	Tata Institute
Marcus Sarkis	Worcester Polytechnic Institute

Renate Scheidler*	University of Calgary
Kurt Sebastian	Flagler College
Jie Shen*	Purdue University
Yeonjong Shin	Brown University
Michael Shoushani	Western Connecticut State University
Chi-Wang Shu*	Brown University
Luca Sodomaco	University of Florence
Jonathan Sorenson	Butler University
Brianna Sorenson	Butler University
Frank Sottile	Texas A&M University
Zheng Sun	The Ohio State University
Jiguang Sun	Michigan Technological University
Li-yeng Sung	Louisiana State University
Andrew Sutherland	Massachusetts Institute of Technology
Mark Sweeney	Brown University
Daniel Szyld	Temple University
Jingye Tan	University at Buffalo
Qi Tao	NWNU
Marilyn Vazquez Landrove	ICERM
Homer Walker	Worcester Polytechnic Institute
Shawn Walker	Louisiana State University
Ying Wang	University of Oklahoma
Kening Wang	University of North Florida
Wei Wang	Florida International University
Jonathan Webster	Butler University
Max Weinreich	Brown University
Olof Widlund*	NYU
Jie Xu	Purdue University
Yunan Yang	New York University
Yang Yang	Michigan Technological University
Xinyue Yu	brown university
Yue Yu	Lehigh University
Xinli Yu	Temple University
Yi Yu	Worcester Polytechnic Institute
Jiayu Zhai	University of Massachusetts Amherst
Xu Zhang	Mississippi State University
Shangyou Zhang	University of Delaware
Hongchao Zhang	Louisiana State University
Yi Zhang	University of North Carolina at Greensboro
Xiangxiong Zhang	Purdue University
Jia Zhao	Utah State University
Feng Zheng	Xiamen University
Ludmil Zikatanov	Penn State
Paul Zimmermann*	INRIA

*Workshop speaker

There were no exit surveys collected by ICERM for this program.

Collaborate@ICERM (C@I)

ICERM hosted 9 Collaborate@ICERM programs from May 2018 to April 2019.

Collaborate@ICERM offers teams of 3-6 researchers the opportunity to spend five days at the institute during the summer (May-August) or during the month of January. The team research project should have a computational or experimental component. ICERM provides access to a variety of software packages as well as to high performance computing through Brown's Center for Computation and Visualization.

Proposals involving research projects that continue a collaboration fostered at one of the past ICERM semester programs are encouraged. Collaborate@ICERM provides limited funding for travel to the institute and local accommodations for six nights. The majority of participants must be from U.S. institutions. The entire team should be present for the week at ICERM.

Collaborate@ICERM Process

1. Solicitation of Proposals

ICERM solicits proposals from faculty through announcements about the opportunity during welcoming remarks at other ICERM programs, and calls for proposals in quarterly newsletters.

Though it is not required, Collaborate@ICERM proposers are welcome to contact the ICERM Director prior to submitting a proposal for preliminary feedback.

The 2-3 page Collaborate@ICERM proposal should include a research title and the list of team members on the first page, as well as:

- Broad research objectives and specific goals for the week at ICERM, written for a general mathematical audience
- Members of the team (3-6)
- The case for convening at ICERM
- A list of possible dates (5 weekdays in May-August or in January)
- 2-page CVs for each team member.

2. Deadline and Review Process

Completed proposals should be submitted to the ICERM Director. Annual target deadlines are October 1st and May 1st. ICERM Directors and the Scientific Advisory Board (SAB) review all proposals. Proposers receive feedback within a month of the SAB meeting.

Collaborate@ICERM Participants and Projects

C@I 1: Adaptive Multilevel Monte Carlo Finite Element Methods: Overcoming Complex Physics in Subsurface Flow through Efficient Computing (June 11 - 15, 2018)

- Eric Hall, University of Massachusetts Amherst
- Haakon Hoel, Chalmers University of Technology
- Mattias Sandberg, Kungliga Tekniska Högskolan (KTH) Royal Institute of Technology

C@I 2: Unipotent elements of the symmetric spaces of SL3(k) and SL4(k) (June 16 - 20, 2018)

- Catherine Buell, Fitchburg State University
- Aloysius Helminck, College of Natural Sciences, University of Hawai'i at Manoa
- Vicky Klima, Appalachian State University
- Jennifer Schaefer, Dickinson College
- Carmen Wright, Jackson State University
- Ellen Ziliak, Benedictine University

C@I 3: High Order Semi-implicit IMEX WENO Schemes for Isentropic Euler System with All-Mach Number (June 23 - 27, 2018)

- Sebastiano Boscarino, Univesrity of Catania
- Mingchang Ding, University of Delaware
- Linjin Li, University of Delaware
- Jingmei Qiu, University of Delaware
- Giovanni Russo, Università di Catania
- Tao Xiong, Xiamen University

C@I 4: Control and Analysis of Large-Scale Time-Varying Data (August 6 - 10, 2018)

- Natalie Durgin, Spiceworks
- Rachel Grotheer, Goucher College
- Chenxi Huang, Yale/YNHH Center for Outcomes Research and Evaluation
- Shuang Li, Colorado School of Mines
- Anna Ma, Claremont Graduate University
- Deanna Needell, UCLA
- Jing Qin, Montana State University

C@I 5: Circle Packings and Geometric Rigidity (August 6 - 10, 2018)

- Philip Bowers, The Florida State University
- John Bowers, James Madison University
- Robert Connelly, Cornell University
- Steven Gortler, Harvard
- Wai Yeung Lam, Brown University
- Anthony Nixon, Lancaster University
- Kenneth Stephenson, University of Tennessee

C@I 6: Asymptotic Topology of the Perceptron Model (August 13 - 17, 2018)

- Antonio Auffinger, Northwestern
- Antonio Lerario, SISSA (International School for Advanced Studies)
- Erik Lundberg, Florida Atlantic University

C@I 7: Mean Reeb Graphs (August 20 - 24, 2018)

- Ellen Gasparovic, Union College
- Elizabeth Munch, Michigan State University

- Steve Oudot, Inria
- Katharine Turner, ANU
- Bei Wang, University of Utah
- Yusu Wang, Ohio State University

C@I 8: Topological Data Analysis and Music Information Retrieval (January 7 - 11, 2019)
- Erin Bugbee, Brown University
- Katherine Kinnaird, Smith College
- Melissa McGuirl,University of Texas at Austin
- Claire Savard, University of Colorado

C@I 9: A Broken Circuit Model For Chromatic Symmetric Homology (February 4 - 8, 2019)
- Alex Chandler, North Carolina State University
- Radmila Sazdanovic, North Carolina State University
- Salvatore Stella, University of Haifa
- Martha Yip, University of Kentucky

Note: ICERM sends exit surveys to Collaborate@ICERM participant groups 6 months after their meetings. For exit survey reports from the 2018 Collaborate@ICERM programs listed above, see Appendix C.

TRIPODS Workshops

Brown University's Data Science Initiative partners with ICERM on public events, included workshops supported by the TRIPODS grant from the National Science Foundation. During this reporting cycle, ICERM provided space and staff support for three TRIPODS program

TRIPODS 1: Summer Bootcamp Topology and Machine Learning
August 6-10, 2018

Organizing Committee:
Henry Adams, Colorado State University
Jeffrey Brock, Brown University
Melissa McGuirl, Brown University
Bjorn Sandstede, Brown University
Yitzchak Solomon, Brown University

Program Description:
Modern data analysis presents a variety of challenges, including the size, the dimensionality, the complexity, and the multiple-modality of the data. In an attempt to keep pace with these growing challenges, data scientists combine tools inspired from mathematics, from computer science, and from statistics. This TRIPODS Summer Bootcamp will provide attendees a hands-on introduction to emerging techniques for using topology with machine learning for the purpose of data analysis.

Topological and machine learning techniques potentially play complimentary roles for analyzing data. In topological data analysis, one leverages the fact that the shape of the data often reflects important and interpretable patterns within, although topological techniques alone typically cannot match the predictive power of machine learning. By contrast, machine learning algorithms provide state-of-the-art accuracies on predictive tasks, but the manner by which they arrive at a prediction is often difficult to interpret. Machine learning would benefit if one could use mathematics to provide more interpretability, even in exchange for reduced predictive power. There are by now a variety of ways to combine topology with machine learning, and the diversity of such approaches is growing. The goal of the TRIPODS Summer Bootcamp is to expose attendees to current tools combining topology and machine learning. The bootcamp will focus not only the successes of such algorithms but also on their inherent challenges, in order to inspire the development of novel approaches.

The bootcamp will consist of a hands-on tutorial during days 1-3, and a research conference during days 4-5.

Days 1-3: Introductory tutorial on applied topology and machine learning
The first three days of the bootcamp will include an introductory tutorial on applied topology, on machine learning, and on the marriage between the two. The featured topic from applied topology will be persistent homology, and the featured topic from machine learning will be classical algorithms such as clustering, support vector machines (SVM), and random forests. Finally, featured topics for combining persistent homology with machine learning will include the bottleneck or Wasserstein distances, persistence landscapes, and persistence images. The tutorial will emphasize hands-on coding exercises with real data. Participants will compare the performance and interpretability of standard algorithms on a variety of machine learning tasks, and they will also create and test variants of their own invention.

We will be doing computational exercises to accompany the bootcamp. Please see our tutorial at https://github.com/ICERM-TRIPODS-Top-ML/Top-ML/wiki and our code at https://github.com/ICERM-TRIPODS-Top-ML/Top-ML.

Days 4-5: Research conference on topology and machine learning
The final two days of the bootcamp will feature a research conference on current trends in topology and machine learning. The conference will be targeted at a more expert audience not necessarily present at the preparatory bootcamp tutorials during the first three days.

TRIPODS 2: Building Community in the Foundations of Data Science
August 13-14, 2018

Organizing Committee:
Jeffrey Brock, Yale University
Bjorn Sandstede, Brown University

Program Description:
Building Community in the Foundations of Data Science

Brown's NSF TRIPODS grant is sponsoring a two-day informal networking workshop for the greater New England Foundations of Data Science community. In a series of informal discussions and short talks, we would like to draw attention to the opportunities to collaborate in foundational questions that lie at the focus of our TRIPODS program:

- structure of large and complex networks
- causal inference
- geometry and topology of data

We invite short talks on how these or other foundational or methodological data science themes appear in ongoing research projects in your work. We will spend the afternoon of the second day engaging in brainstorming for how collaborative structures across institutions can build and strengthen data science activity in the region.

TRIPODS 3: Models and Machine Learning for Causal Inference and Decision Making in Health Research
January 14-18, 2019

Organizing Committee:
Joseph Hogan, Brown University

Program Description:
Causal and mathematical models are widely used for decision making and policy evaluation at both the micro and macro levels. For example, causal models using large datasets are used to evaluate treatment efficacy in HIV; mathematical models are used to simulate the effects of prevention or policy measures to improve health outcomes or reduce the spread of infectious diseases. Entities such as the World Health Organization and UNAIDS rely on these models to set wide-ranging and high-impact policy related to treatment and prevention of infectious disease.

Causal models tend to rely on large-scale cohort data, while mathematical models in many ways represent evidence synthesis. Important methodologic issues in the development, application, and interpretation of these models include the role of untestable assumptions, transportability of findings to specific populations of interest, model calibration and validation, and uncertainty quantification. The datasets used to develop these models are complex in nature.

This workshop will bring together leading researchers in the areas of modeling, machine learning and causal inference to delve more deeply into foundational and methodologic issues and their implications, illustrate the use of these models in real-world settings, and draw connections between the two approaches.

Key questions to be addressed and discussed include:

- What is the role of an underlying causal model in decision making?
- How do we quantify uncertainty from multiple sources, such as model selection, untestable assumptions, prediction uncertainty?
- What is the role of predictive models in causal inference?

- What are the connections between statistical models and mathematical agent-based models for drawing causal inferences?
- What is the role of machine learning in inferring causal relationships and decision making?
- How should methods be adapted to specialized settings (e.g., social networks)?

Hot Topics Workshops

ICERM is the recipient of one of the Simons Foundation Targeted Grants to Institutes. The Simons funding, totaling nearly $1 million over 5-years (2017-2021), enhances and expands ICERM's efforts to bring top scholars to the institute to explore big questions in mathematical research.

ICERM uses the additional funding to improve financial support for the academic leaders of the institute's semester-long topical conferences and workshops.

In this reporting year, ICERM also started using these funds to launch its "Hot Topics" workshop program. Hot Topics workshops are designed to allow ICERM to move quickly in order to start the public exploration of breakthroughs and emerging mathematical areas. They run 2-3 days and are organized on a few months' notice. They can originate through suggestions from ICERM boards or the community. The Simons Foundation Targeted Grant provides financial support of around $50K for each Hot Topics workshop, including honoraria to attract key speakers and organizers.

The institute welcomes suggestions for Hot Topics Workshops and encourages researchers to contact the ICERM Director with ideas. The Director and a SAB Hot Topics subcommittee considers proposals for such workshops, which should include:

- List of potential organizers
- Description of the program area/theme (1 paragraph)
- Explanation about why it is a "Hot Topic" (1 paragraph)
- List of 8-10 high-level speakers/participants, their research areas, and how they connect to the goals of the workshop.

Hot Topics suggestions are accepted on a rolling basis. Suggestions are considered by the ICERM Directors, and a sub-committee of ICERM's Scientific Advisory Board that decides which ideas are developed into workshops. ICERM responds to all Hot Topics suggestions within two weeks.

Hot Topics Workshop 1: Scientific Machine Learning
January 28-30, 2019

Organizing Committee:
Jan Hesthaven, Ecole Polytechnique Federale de Lausanne
George Karniadakis, Brown University

Workshop Description:

The machine learning revolution is already having a significant impact across the social sciences and business, but it is also beginning to change computational science and engineering in fundamental and very varied ways.
We are experiencing the rise of new and simpler data-driven methods based on techniques from machine learning such as deep learning. This revolution allows for the development of radical new techniques to address problems known to be very challenging with traditional methods and suggests the potential dramatic enhancement of existing methods through data informed parameter selection, both in static and dynamic modes of operation. Techniques are emerging that allows us to produce realistic solutions from non-sterilized computational problems in diverse physical sciences.

However, the urgent and unmet need to formally analyze, design, develop and deploy these emerging methods and develop algorithms must be addressed. Many central problems, e.g., enforcement of physical constraints in machine learning techniques and efficient techniques to deal with multiscale problems, are unmet in existing methods.

The primary goal of this Hot Topic workshop is to bring together leading researchers across various fields to discuss recent results and techniques at the interface between traditional methods and emerging data-driven techniques to enable innovation in scientific computing in computational science and engineering.

This workshop is fully funded by a Simons Foundation Targeted Grant to Institutes.

Hot Topics Workshop 2: Modularity and 3-manifolds
January 28-30, 2019

Organizing Committee:
Miranda Cheng, University of Amsterdam
Sergei Gukov, Caltech
Workshop Description:

A long-standing problem in quantum topology is to find a function, more precisely a q-series with integer coefficients, such that its limiting values at primitive roots of unity yield invariants of Witten and Reshetikhin-Turaev. In other words, such a function would be to 3-manifolds what the Jones polynomial is to knots. Somewhat surprisingly, recent physics developments suggest that, in order to solve this problem, one must associate to a 3-manifold not a single function (q-series), but rather a collection of functions. Very recently, based on both physical intuition and explicit computations, it was suggested that these 3-manifold invariants display (modified) modularity properties of various types and are related to number theoretic objects including mock and false theta functions and quantum modular forms. This workshop will bring experts from the fields of topology, physics and number theory together, with the goal of combining knowledge and computational skills and furthering the understanding of the modular properties of the 3-manifold invariants.

This workshop is fully funded by a Simons Foundation Targeted Grant to Institutes.

Program Promotions

ICERM programs and events are marketed through a variety of outlets: its website, dedicated Facebook page, Twitter, Instagram, and LinkedIn accounts, targeted blast emails, posters mailed to purchased targeted university and college lists, placement of advertisements in mathematical journals and newsletters, director participation in conferences and exhibits, upcoming program fliers and announcements made available to all ICERM participants, and various on-line math organization calendars (SIAM, AMS, NAM, European Mathematical Society, National Math Institutes, and Conference Service Mandl, etc.).

ICERM's email database is made up of former and upcoming participants, ICERM board members, academic and corporate sponsors, and the department managers from higher education math departments in both the US and overseas. It currently has over 4,000 contact emails. Posters for ICERM's summer undergraduate research program (Summer@ICERM) are target-mailed to institutions known to have undergraduate programs in mathematics, applied math, and computer science.

During the 2018-2019 reporting cycle, ICERM either hosted or had a speaker, a booth and/or joint representation with other institutions at the following locations and national events:

- Sponsored a booth at Modern Math Workshop at SACNAS, Fall 2018 (San Antonio, TX)
- Sponsored a booth at Mathematical Field of Dreams Conference, Fall 2018 (St. Louis, MO)
- Hosted the Blackwell-Tapia conference and award banquet, Fall 2018 (Providence, RI)
- Hosted an ICERM Mixer, sponsored a table at NSF Math Institutes reception, and worked a shared NSF Math Institutes booth at the Joint Mathematics Meeting (JMM), Winter 2019 (Baltimore, MD)

All program advertising emphasizes diverse participation and uses language encouraging minority and under-represented students to apply. More details about this can be found in the "Outreach/Diversity" section of this report.

Communications Plan

During this reporting cycle, ICERM launched several parts of its communications plan: social media postings are now streamlined and more robust, the annual newsletter is now a quarterly newsletter, funders are appropriately listed on program and info webpages, ICERM has a presence on the university's "Brunonia" fundraising page, and we've framed and started to ramp-up opportunities for people to donate to ICERM and formally thank our donors. These efforts have helped ICERM maintain contact with recent, current and upcoming program participants, board members, corporate and academic sponsors, and the general population. Brown has committed to supporting ICERM's Provost-approved fundraising goals; ICERM is now part of Advancement's portfolio, overseen by their new Director of Development for Academic Initiatives. Brown's Foundation Relations group will also continue to help ICERM build relationships with corporations and foundations.

Organization/Infrastructure

ICERM's governing body is a Board of Trustees (BOT). The Scientific Advisory Board (SAB) oversees all scientific activities of the Institute and selects the scientific programs. The Education Advisory Board, or EAB coordinates the oversight of educational activities at all levels at ICERM. This year, ICERM adjusted all of the board terms to a July-June cycle, which makes keeping track of membership status and recruiting easier.

Board of Trustees (BOT)

The Board of Trustees oversees all institute activities. This includes being responsible for reviewing the budget for the coming year, developing policies and procedures, advising on the appointment of new directors and actively recruiting for the position as needed, and taking a leadership role in fundraising and public awareness. The Board of Trustees has a face-to-face meeting at ICERM for one day each year (usually in late spring), and one or two conference-call meetings if needed.

Board of Trustee member appointments are for four years. Chairs from the Scientific Advisory Board (SAB) and the Education Advisory Board (EAB), as well as the ICERM Directors, act as ex officio members.

Board of Trustee Members:

Name	Institution
Douglas Arnold	University of Minnesota
Sir John Ball	Heriot-Watt University
Jennifer Chayes	Microsoft Research
Charles Epstein	University of Pennsylvania
Bruce Hendrickson	Lawrence Livermore National Laboratory
Peter Jones (Chair)	Yale University
David Keyes	Columbia University/KAUST
Yann LeCun	NYU and Director of Research, Facebook
Jonathan Mattingly	Duke University
Jill Mesirov	University of California, San Diego
Jill Pipher	Brown University

Note: The minutes from the May 30, 2018 annual Board of Trustees meeting and January 29, 2019 call be found in Appendix D.

Scientific Advisory Board (SAB)

The Scientific Advisory Board (SAB) is responsible for approving the programs and scientific activities of the Institute. In addition, through direct communication with the Directors, Science Board members will be involved in shaping the direction of the scientific enterprise through specific suggestions of thematic programs, program organizers.

Terms are three years. The ICERM Directors and Brown's Director of the Data Science Initiative (Bjorn Sandstede) act as ex officio members of this committee.

Scientific Advisory Board Members:

Name	Institution
Liliana Borcea	University of Michigan
Jeffrey Brock	Yale University
Henry Cohn	Microsoft Research
Jesús De Loera	University of California, Davis
Qiang Du	Columbia University
Vanja Dukic	University of Colorado, Boulder
Charles Epstein (Chair)	University of Pennsylvania
Rachel Kuske	Georgia Institute of Technology
Anna Lysyanskaya	Brown University
Ricardo Nochetto	University of Maryland
Kavita Ramanan	Brown University
Joseph Silverman	Brown University
Carol Woodward	Lawrence Livermore National Laboratory

Liliana Borcea, Jesús De Loera, and Anna Lysyanskaya joined the SAB in 2018. Anna Schilling (2015-2018), Cosma Shalizi (2015-2018), and Rich Schwartz (2013-2018) rotated off in 2018.

Note: The minutes from the May 22, 2018 mid-year SAB conference call and the November 11-12, 2018 SAB annual meeting can be found in Appendix E.

Education Advisory Board (EAB)

The Education Advisory Board 1) oversees the undergraduate research programs, and helps to develop and identify successful proposals, 2) helps to develop proposals for outreach programs and events that are aligned with the mission of the institute, and 3) helps to identify sources of funding for education and outreach activities.

Terms are three years. The ICERM Directors act as ex officio members of this committee.

Education Advisory Board Members:

Name	Institution
John Ewing	Math for America
Karen Haberstroh	Brown University
Katharine A. Ott (Chair)	Bates College
Lynn Rakatansky	RI Mathematics Teachers Association Executive Board
Sergei Tabachnikov	Pennsylvania State University
Ulrica Wilson	Morehouse College

Sergei Tabachnikov stepped down as Chair of the SAB in 2018, replaced by Katharine Ott.

Note: The minutes from the September 21, 2018 annual Education Advisory Board meeting can be found in Appendix F.

Mathematics Institute Directors Meeting (MIDs)

The April 26-27, 2019 MIDs meeting minutes can be found in Appendix G.

ICERM's Early Career Training and Mentorship

A special focus of the operations of the institute is the training and mentorship of younger and early career mathematicians, through specific outreach programs and directed opportunities for connections between mathematicians at different stages in their career. This includes ICERM's postdoctoral program, integration and support of graduate students in the context of semester programs, and summer research programs for undergraduates (Summer@ICERM). The addition of postdoctoral fellows (as described above) and graduate students is essential to the success of ICERM's programs.

Postdoctoral Program

ICERM's postdoctoral program brings early career mathematicians to the institute in order to support and expand their research and to create lasting career collaborations and connections. ICERM supports postdoctoral researchers in two salaried categories: "Semester" postdoctoral fellows who participate in a single semester-length program, and a smaller number of "Institute" postdoctoral fellows, who stay at ICERM for an academic year.

Recruiting and Selection of ICERM-Funded Postdocs

ICERM's postdoctoral positions are widely advertised using MathJobs.org, print and online publications of the Society for Industrial and Applied Mathematics News, Notices of the American Mathematical Society, the Association of Women in Mathematics, the Society for the Advancement of Chicanos and Native Americans in Science, and on the ICERM website. These positions are also advertised at the NSF Institute Reception at the joint meetings of the AMS/MAA. ICERM collects applications via Mathjobs.org, an online job application service provided by the American Mathematical Society.

In all written material sent out, it is emphasized that Brown is an EEO/AA Employer and that ICERM encourages applications from women and minority candidates.

ICERM sets an early-January deadline for postdoctoral applications. Application review begins immediately and continues until the positions are filled.

The Postdoctoral Fellow Search Committee consists of the ICERM Semester Program organizers for the upcoming programs with input for the Directorate.

The program organizers review all of the applications and provide a rank-ordered list to the ICERM Directors for each of the two types of positions (Semester and Institute postdocs). The Directorate reviews the total applicant pool and the ranked lists, and may suggest changes. The Director approves all offers, and Brown University's Dean of the Faculty generates the appointment paperwork.

2018-2019 ICERM Postdoctoral Cohort

ICERM Postdoctoral Fellows (4 months w/benefits; funds for travel to and from institute)

Name	Previous Institute	ICERM Semester Program
Daniel Bernstein	North Carolina State University	Fall 2018
Papri Dey	IIT Bombay	Fall 2018

Mareike Dressler	Goethe-Universitaet Frankfurt	Fall 2018
Kathlén Kohn	University of Oslo	Fall 2018
Sara Lamboglia	University of Warwick	Fall 2018
Dane Wilburne	York University	Fall 2018
Guangyao Zhou	Brown University	Spring 2019

ICERM Institute Fellows (9 months w/benefits; funds for travel to and from institute)

Name	**Previous Institute**	**ICERM Semester Program**
Shubhendu Trivedi	Toyota Technological Institute at Chicago	2018-2019: focus on Spring 2019
Marilyn Vazquez	George Mason University	2018-2019: focus on Spring 2019

Despite ICERM's efforts, the institute found it difficult to recruit semester postdocs for the spring 2019 program, either due to visa issues or the non-traditional nature and length of the semester program for researchers in the field of Computer Vision.

Based on available information, the ICERM stipend-supported postdocs for 2018-2019 break down as follows:

	Male		**Female**	
Black	0		0	
Hispanic	0		1	
American Indian/Alaskan Native	0		0	
Asian/Pacific Islands	2		1	
White	2		3	
Other (specify)	0	+	0	
	4		5	= 9 Total

Tracking Former Postdocs (Institute and Semester)

ICERM Research Fellows are supported with a salary for one semester. We expect that these postdoctoral fellows will be on leave from, or have deferred the start of, another position. The institute makes every effort to keep in touch with its postdoctoral alums in order to track their professional growth.

ICERM-funded postdocs ***(to date)***	**Period of Stay**	**Where are they as of Spring 2019?**
Emre Esenturk	Fall 2011	University of Warwick
Jeffrey Haack	Fall 2011	Los Alamos National Laboratory
Andong He	**Fall 2011**- Spring 2012	Passed away in 2016
Ahmed Kaffel	Fall 2011	Marquette University
Daniela Tonon	Fall 2011	Maître de Conférence, Université Paris Dauphine
Dongming Wei	Fall 2011	Director RBC Capital Markets
Cecile Armana	Spring 2012	University of Franche-Comté
Anupam Bhatnagar	Spring 2012	Senior Data Scientist at Unity Technologies
Alon Levy	Fall 2011 – **Spring 2012**	Transit Writer at the Marron Institute

Bianca Viray	Spring 2012	University of Washington
Xiaoguang Wang	Spring 2012	Zhejiang University
Daniel Cargill	Fall 2012	Operations Research Analyst at Air Force Research Laboratory
Arnab Ganguly	Fall 2012	Louisiana State University
Peng Hu	Fall 2012	Oxford-Man University
Hao Ni	Fall 2012	University College
Aaron Smith	**Fall 2012** - Spring 2013	University of Ottawa
Julio Andrade	Fall 2012 - **Spring 2013**	Universty of Exeter
Kwangho Choiy	Spring 2013	Southern Illinois University
Zajj Daugherty	Spring 2013	CUNY
Martina Lanini	Spring 2013	Università di Roma Tor Vergata
Ben Salisbury	Spring 2013	Central Michigan University
Ryan Greene	Fall 2013	The Ohio State University
BoGwang Jeon	Fall 2013	Columbia University
Rodolfo Rios-Zertuche	Fall 2013	Ecole Normale Supérieure
Giulio Tiozzo	**Fall 2013** – Spring 2014	University of Toronto
Anastasiia Tsvietkova	Fall 2013	Rutgers University
Kyle Fox	Spring 2014	University of Texas at Dallas
Danupon Nanongkai	Spring 2014	KTH
Amanda Redlich	Spring 2014	UMASS Lowell
Charalampos Tsourakakis	Spring 2014	Boston University
Grigory Yaroslavtsev	Fall 2013 - **Spring 2014**	Indiana University
Ali Ahmed	Fall 2014	Information Technology University (Lahore)
Ulas Ayaz	**Fall 2014** – Spring 2015	MIT
Jacqueline Davis	Fall 2014	Arizona State University
Pawel Siedlecki	Fall 2014	Polish Academy of Science
Li Wang	Fall 2014	University of Illinois
Tyler Helmuth	Spring 2015	University of Bristol
Marcin Lis	Spring 2015	University of Cambridge
Emily Russell	Fall 2014 – **Spring 2015**	Google
Xuan Wang	Spring 2015	Data Scientist at Databricks
Samuel Watson	Spring 2015	Brown University/DSI
Olga Balkanova	Fall 2015	University of Gothenburg
Sandro Bettin	Fall 2015	University of Genova
Edgar Costa	Fall 2015	MIT
Anna Medvedovsky	**Fall 2015** – Spring 2016	Max Planck Institute
James Weigandt	**Fall 2015** – Spring 2016	Purdue University
Abel Farkas	Spring 2016	Hungarian Academy of Sciences
Marta Canadell	Fall 2015 – **Spring 2016**	Annalect
Nishant Chandgotia	Spring 2016	Einstein Institute of Mathematics
Zhiqiang Li	Spring 2016	Peking University
Polina Vytnova	Spring 2016	University of Warwick
Hannah Alpert	**Fall 2016** – Spring 2017	The Ohio State University
Chaim Even-Zohar	Fall 2016	University of California, Davis
Isaac Mabillard	Fall 2016	Google
Greg Malen	Fall 2016	Duke University

Jose Alejandro Casas	Fall 2016	University of Miami
John Wiltshire-Gordon	Fall 2016	University of Wisconsin, Madison
Sergey Dyachenko	Fall 2016 – **Spring 2017**	University of Illinois, Urbana-Champaign
Seok Hyun Hong	Spring 2017	Pohang University
Cecilia Mondaini	Spring 2017	Tulane University
Olga Trichtchenko	Spring 2017	Western University
Xeucheng Wang	Spring 2017	Tsinghua University
Xiaoqian Xu	Spring 2017	Carnegie Mellon University
Mario Bencomo	**Fall 2017** – Spring 2018	Rice University
Wei Li	Fall 2017	Louisiana State University
Shixu Meng	Fall 2017	University of Michigan
Yimin Zhong	Fall 2017	University of California, Irvine
David de Laat	Spring 2018	Emory University
Maria Dostert	Spring 2018	EPFL
Philippe Moustrou	Spring 2018	University of Tromsø
Yuguang Wang	Spring 2018	University of New South Wales
Wei-Hsuan Yu	Fall 2017 – **Spring 2018**	National Central University in Taiwan
Daniel Bernstein	Fall 2018	MIT
Papri Dey	Fall 2018	Simons Institute, Berkeley
Mareike Dressler	Fall 2018	University of California - SD
Kathlén Kohn	Fall 2018	Chalmers University of Technology
Sara Lamboglia	Fall 2018	Max Planck Institute
Dane Wilburne	Fall 2018	York University
Marilyn Vazquez	Fall 2018 – **Spring 2019**	Postdoc at MBI
Shubhendu Trivedi	Fall 2018 – **Spring 2019**	MIT CSAIL
Guangyao Zhou	Spring 2019	To be determined

Graduate Students

Support for Graduate Students

The research semester program budget includes partial support for a cohort of graduate students. A housing allowance $900/month and travel to the institute is provided to about 10-14 graduate students each of whom applies to be in residence for the entire semester. Applicants include graduate students working with visitors to the program, as well as students who intend to come without an advisor. Graduate students must arrange for a letter of recommendation from their advisor to be sent separately. The graduate student applications are rank-ordered by the semester program organizing committee and subsequently reviewed by the Deputy Director overseeing the development of that particular program. Final decisions are made by the directors. The ability to provide a mentor for each graduate student in residence is a factor in the decision.

Training and Mentoring Programs

Before an ICERM semester program starts, all postdocs and graduate students are assigned a mentor. The institute provides all senior mentors with written guidelines that spell out their responsibilities and the responsibilities of mentees. Currently, Associate Director Caroline Klivans coordinates these efforts and works with the members of the Program Organizing Committee assigned to be responsible for mentorship.

In addition, at the beginning of each semester program, directors hold mentor/mentee introductory meetings. These meetings emphasize that mentors should help mentees start to build a research cohort and help them create contacts and resources which will persist beyond the program.

The mentoring program for the Institute Postdoctoral Fellows necessarily includes a plan for the "off semester" when these postdocs are in residence at ICERM while there is no active research program in their area. In most cases, postdocs are matched with mentors at Brown in Math, Applied Math, or Computer Science in order to continue their ICERM research. During this reporting cycle, there was no Fall Institute Postdocs due to issues with securing a visa for the candidate. Spring Institute Postdoc Shubhendu Trivedi stayed at ICERM and was mentored by R. Barzilay. The other Spring Institute Postdoc, Marilyn Vasquez was at ICERM for the academic year and was mentored by Spring 2019 program organizer Pedro Felzenswab.

ICERM Postdoctoral Participant and Mentor list by Semester Program

Postdoc	Mentor	Program
Daniel Bernstein	Elisa Gorla	Fall 2018 ICERM Postdoctoral Fellow
Papri Dey	Jonathan Hauenstein	Fall 2018 ICERM Postdoctoral Fellow
Mareike Dressler	Greg Blekherman	Fall 2018 ICERM Postdoctoral Fellow
Kathlén Kohn	Melody Chan	Fall 2018 ICERM Postdoctoral Fellow
Sara Lamboglia	Josephine Yu	Fall 2018 ICERM Postdoctoral Fellow
Dane Wilburne	Elizabeth Gross	Fall 2018 ICERM Institute Postdoc
Carlos A. Ceran*	B. Sturmfels & C. Haase	Fall 2018 ICERM/Independent
Justin Chen*	Anton Leykin	Fall 2018 ICERM/Independent
Eliana Duarte Gelvez*	Thomas Kahle	Fall 2018 ICERM/Independent
Fulvio Gesmundo*	J.M. Landsberg	Fall 2018 ICERM/Independent
Kaie Kubjasa*	C. Uhler	Fall 2018 ICERM/Independent
Felipe Rincón*	Bernd Sturmfels	Fall 2018 ICERM/Independent
Tingran Gao	Mario Parente	Spring 2019 ICERM/Independent
Kathlén Kohn	Melody Chan	Spring 2019 ICERM/Independent
Patricia Medina	James Tompkins	Spring 2019 ICERM/Independent
Michael Northington	David Jacobs	Spring 2019 ICERM/Independent
Shubhendu Trivedi	R. Barzilay & B. Gidas	Spring 2019 ICERM Postdoctoral Fellow
Marilyn Vazquez	Pedro Felzenszwalb	Spring 2019 ICERM Institute Postdoc
Guangyao Zhou	Stu Gehman	Spring 2019 ICERM Postdoctoral Fellow

*Advisor also attended the program

Graduate Student Mentor List

Graduate Student	Mentor	Program
Iman Bahmani Jafarloo*	Enrico Carlini	Fall 2018
Taylor Brysiewicz*	A. Leykin & F Sottile	Fall 2018
Timothy Duff*	Anton Leykin	Fall 2018
Oliver Gäfvert*	Sandra Di Rocco	Fall 2018
António Goucha*	J. Eduardo da Silveira Gouveia	Fall 2018
Marc Harkonen*	Anton Leykin	Fall 2018
Cvetelina Hill*	Josephine Yu	Fall 2018

Nidhi Kainsa*	Bernd Sturmfels	Fall 2018
Kisun Lee*	Anton Leykin	Fall 2018
Lillian Pasley*	Cynthia Vinzant	Fall 2018
Margaret Regan*	Jonathan Hauenstein	Fall 2018
Michael Ruddy*	I. Kogan & C. Vinzant	Fall 2018
Georgy Scholten*	Cynthia Vinzant	Fall 2018
Samantha Sherman*	Jonathan Hauenstein	Fall 2018
Lily Silverstein*	Jesus De Loera	Fall 2018
Luca Sodomaco*	Elisa Gorla	Fall 2018
Muzammil Behzad	Daphna Weinshall	Spring 2019
Shermin Hamzehei	Pedro Felzenszwalb	Spring 2019
Shira Kritchman	Ronen Basri	Spring 2019
Jeová Neto*	Pedro Felzenszwalb	Spring 2019
Anna Grim*	Pedro Felzenszwalb	Spring 2019
Ömer Sümer	David Jacobs	Spring 2019

*Advisor also attended the program/acted as mentor

Roundtable Discussions

To prepare graduate students and postdocs better for their future careers, the institute also organizes regular roundtable discussions with long-term visitors, Brown faculty, and directors, that in the course of each semester, cover the following topics:

- Preparing job applications
- Writing and submitting papers
- Writing grant proposals
- Ethics in research as required by NSF – mandatory, attendance is taken
- Job opportunities in industry and government labs

Peer-to-Peer Discussions

During semester programs, there are regularly scheduled postdoc-graduate student seminars, expressly limited to junior researchers. This gives participating postdocs and graduate students an opportunity to discuss research topics and any other issues openly, without senior people present. The format is completely flexible. For example, it could feature talks by postdocs or graduate students on their current research or provide an opportunity to read and report on papers, or give an introduction to upcoming talks in other seminars. The group could even ask a senior participant to give a tutorial lecture and then follow up with a discussion session afterwards.

ICERM makes all of its resource materials for its Graduate Students and Postdoctoral Fellows available to the general public on its website, which can be found at:
https://icerm.brown.edu/pds/

Summer Undergraduate Research Program

Summer@ICERM is an eight-week summer research program for 16-20 undergraduates. Students work in small groups, typically in pairs, supervised by faculty advisors and assisted by TAs. In addition to research projects, the program includes topical mini-courses and colloquium-

style lectures given by invited speakers. Students present their findings at a symposium at the end of the program.

1. Solicitation of Proposals

ICERM solicits and recruits proposals from faculty nationwide. Faculty organizers and TAs are required to be in residence for a minimum of six of the eight weeks, especially the first and last week of the program.

2. Future Proposal Selection

Programs are selected from proposals submitted to ICERM in an open competition. Successful programs typically have a significant computational component. Summer research programs which pair with the semester programs are especially encouraged, but not required. A subcommittee of the EAB and an Associate Director, vet proposals. External evaluations of proposals are solicited. Preliminary decisions on summer programs are made by the Directors and must be approved by the Education Advisory Board.

3. Application Process

Undergraduates apply to the program through MathPrograms.org and participants are selected from a talented pool of students currently enrolled in U.S. universities and colleges. A small number of international participants may also be admitted.

4. Applicant Selection

Undergraduate participants are selected by the Summer@ICERM faculty organizers and the selections are finalized by ICERM Director(s). At all stages of recruitment, solicitation, and selection, the organizers are instructed about the diversity goals of the National Science Foundation, and ICERM in particular. To ensure a diverse group of applicants, ICERM advertises and recruits from minority serving organizations.

Financial Decisions for Program

Faculty and TAs receive a stipend and travel support, and faculty also get partial or full support for lodging. Undergraduate participants funded by ICERM receive a stipend, travel funds within the United States, meals, and accommodation in a Brown dormitory.

Summer 2018: Summer@ICERM – Low Dimensional Topology and Geometry

June 11 – August 3, 2018

Organizing Committee:
Tarik Aougab, Brown University
Moira Chas, Stony Brook University
Jonah Gaster, McGill University
William Goldman, University of Maryland

Program Description
The 2018 Summer@ICERM program at Brown University is an eight-week residential program designed for a select group of 16-20 undergraduate scholars from around the world.

The faculty advisers will present a variety of research projects that are interdisciplinary and represent areas in low-dimensional topology, hyperbolic geometry, dynamics, and combinatorics. Student researchers will have the opportunity to explore theoretical problems at the intersections of these subfields, and to help design software packages for visualizing and experimenting with the building blocks of hyperbolic and affine geometry.

The faculty will begin the program with brief introductory talks. Throughout the eight-week program, students will work on assigned projects in groups of two to four, supervised by faculty advisors and aided by teaching assistants. Students will meet daily, give regular talks about their findings, attend mini-courses, guest talks, and professional development seminars, practice coding, and learn Tex. Students will learn how to collaborate mathematically, and they will work closely in their teams to write up their research into a poster and/or paper by the end of the program.

ICERM provides an excellent research environment, and the students and their faculty and TA mentors will have access to shared offices and collaborative space throughout the institute. They also will have access to ICERM's computer facilities and specialized software. ICERM staff will provide logistical support for students and will help build community through fun activities and events.

2018 Proposed Research Project Topics

1. Self-intersection Number of Geodesics
2. Hausdorff Dimension and Hyperbolic Pair of Pants
3. Symmetries of Curve Graph Variants
4. Square Tilings
5. Coloring Problem for Curve and Arc Graphs
6. Curves Intersecting Each Other Twice
7. Navigating the Space of SL_2(C) Characters

2018 Summer@ICERM Cohort

The "Summer@ICERM" program had a cohort of 19 students. 14 students were funded through the NSF; 4 via a Brown University Undergraduate Training and Research Award (UTRA); 1 student was self-funded.

Student Name	Institute	Funding Source
Francisco Castaneda*	Instituto Tecnologico Autonomo de Mexico	NSF
Yassin Chandran*	University of California, Santa Barbara	NSF
Zichen Cui	Reed College	Self-funded
Ajeet Gary*	University of Maryland	NSF
Isnayni Hadi	California State University, Northridge	NSF
Paige Helms	University of California Riverside	NSF
Ian Hill*	James Madison University	NSF
Jae Young Kim	Brown University	UTRA
Max Lahn*	Brown University	UTRA
Jonghyun Lee	Brown University	UTRA
Miguel Lopez*	Boston University	NSF

Aisha Mechery*	Bryn Mawr College	NSF
Simran Nayak*	Brown University	UTRA
John Oakley*	Concordia University Texas	NSF
Emily Rexer	Emory University	NSF
Zoe Riell	Smith College	NSF
Roberta Shapiro*	Rutgers University	NSF
Brandis Whitfield*	Brandeis Universiy	NSF
Alex Xu	University of California, Santa Barbara	NSF

*Received some ICERM funding to present a poster related to S@I at JMM 2019

Here follows a sample of the most substantive comments from our Summer@ICERM participants.

Some Participant Comments for "Describe the highlight of this workshop":

- *The highlight of the program was getting to know all of the amazing undergrads, grad students, and faculty mentors I worked with this summer. It was also awesome, in and of itself, just to have 8 weeks set aside to work on very specific problems (in my favorite research area) in a very motivated and focused environment. In addition, the ICERM facilities are beautiful and make it easy to spend many productive hours each day doing math.*
- *The final presentation! Preparing for the final presentation was so exciting because all of the work we had been doing came to a head, it was extremely satisfying to see all of it collected in a neat presentation, and it felt great to give a long talk about all of the work we had been doing. I also feel that our talk went extremely well. The other talks were also fantastic, and I think the organizers were proud of all our work and preparation.*
- *The combination of mathematical growth and stimulating and healthy human interactions.*
- *The amazing people! The size of the participant was perfect for fostering lots of close connections with math people, including math people who are interested in going to grad school. At ICERM, I felt supported in my research by my group mates. Outside of ICERM, I enjoyed getting to know the variety of people who do math.*
- *The second Diversity/Inclusion/Justice/Equity meeting. And Moon Duchin's talk.*
- *The people involved were wonderful and I really grew mathematically.*
- *Expanding my perspective on the nature of mathematics*
- *Being in an environment that enabled the regular discussion of mathematics, and the immersion with a group of like-minded individuals of varied background.*

Summer@ICERM 2018 Scientific Outcomes to Date

Final Student Presentations

- "Length and Self-intersection Number of Geodesics in Hyperbolic Surfaces" by I. Hadi, B. Whitfield, and A. Xu
- "Hausdorff Dimension of the Limit Set of Hyperbolic Pair of Pants" by F. Castaneda and I. Hill
- "Automorphism Group of the k-Curve Graph" by Y. Chandran, R. Oakley, and R. Shapiro
- "Minimally Intersecting Filling Pair Origamis" by Z. Cui, A. Gary, P. Helms, and T. Kim

- "Super Farey Graphs" by M. Lopez, E. Rexer, and Z. Riell
- "Complete Algebraic Two-Systems on the Surface of Genus 2" by M. Lahn, A. Mechery, and S. Nayak
- "Visualizing Cubic Moduli Spaces" by A. Gary and J. Lee

Posters Presented at JMM 2019 in Baltimore, MD

- Automorphisms of the k-curve graph* (Yassin Chandran, Roberta Shapiro, and Rob Oakley)

*Recipient of the MAA "Outstanding Poster Award" at JMM 2019

The Evaluation Process: Measure to Evaluate Progress

Current Program Evaluation

ICERM continues to work with Strategic Research Group (SRG), an external evaluation company, to build upon its current survey data.

ICERM automates its survey reporting, using templates that display particular variables of interest across participants and over time. In this way, ICERM can easily recognize a pattern of program strengths in certain areas and may be able to tailor aspects of its programs to successfully equip individuals for a thriving and influential research career.

ICERM also successfully creates two and five-year follow-up surveys that are customized to a single participant instead of distributing a broad and generalized survey to all participants. An example of how customized surveys are being used at the institute is the generation of publication lists for each participant. When the survey is sent, Qualtrics reads the unique identification number of the participant stored in the panel database and generates a list of publications previously collected by ICERM staff and assigned to that specific identification number. Then, the surveyed participant is able to identify the publications that can be attributed to his or her time at ICERM. This novel incorporation of a participant-specific generated publication list has been useful in understanding how influential ICERM programs are to one's research career long-term.

Survey response rates

ICERM strives to get the highest response rate for its surveys. The director informs participants that they will receive a survey during the welcoming remarks. In addition, the institute explains within the body of every survey how it handles responses confidentially and why it collects gender and ethnicity data. Reminders are sent one or two weeks after each survey is first sent out. This year, ICERM averaged a 58% response rate on all of its exit surveys.

Measure impact across subgroups

Qualtrics cloud-based software not only aids in creating customizable surveys for participants, but also serves as a platform for analyzing data according to different subgroups of participants e.g., gender, job title, race/ethnicity.

SRG continues to assist ICERM with using the Qualtrics data analysis tools to better understand how the institute's programs impact different subgroups of researchers in both the immediate i.e.,

program exit surveys and intermediate-/long-term i.e., two- and five-years after program participation. Qualtrics also provides the opportunity to analyze longitudinal data, which will be helpful in the analysis of certain programs over time. Ultimately, these analyses will provide information as to how ICERM can alter programs to benefit different types of participants who may be at various points in their research career.

Measure long-term outcomes

Since 2014, ICERM has been administering an intermediate - i.e., two-year follow-up survey to past semester program participants. Using the unique identification numbers and in-survey data analyses as described above, these surveys measure the attributable impact of participation in ICERM research programs by gathering data on published papers, invited talks, and funded or pending grant proposals. These follow-up surveys help us understand the far-reaching impact of ICERM's research programs over time. The average response rate for our two-year follow-up surveys is: 56%. The average response rate for our 5-year follow-up surveys is 36%.

A central tenet of ICERM is that networking, collaboration, and engagement with computational tools promote career growth that would not be possible without engagement with our programs.

To test this, ICERM introduced new methodology for long-term evaluation in 2018. With SRG's help, the institute developed a longitudinal comparison report using the original program exit survey, as well as the 2 and 5-year follow-up survey data for participants from its spring 2013 program. This was ICERM's first effort to connect participant data across surveys (with the use of unique IDs) and generate a more holistic narrative of ICERM's impact over a longer period of time. The results from this report are meant to showcase ICERM's long-term impact on participant careers and their continued perceptions of their time at the institute. Notably, this report examines:

- trends in employment over time
- professional talks
- grant funding submitted and received
- collaborations

ICERM could also use this longitudinal report to track the number of ICERM spin-off programs generated. For example, semester programs leading to Collaborate@ICERM programs, or workshops leading to semester programs.

Early results suggest that ICERM needs a higher response rate to draw meaningful conclusions. Only about 36% of long-term participants respond to the five-year follow-up survey and they may not be representative of the program as a whole. At the recommendation of ICERM's SAB, the institute will enlist organizers to make their own assessments of the long-term impact of the program, share these with participants as a prompt for their own reflections, and integrate survey data with organizer comments in the SAB program reviews.

ICERM continues to play a large role in gathering and updating participant information for the two and five-year follow-up surveys. Specifically, one question provides participants with a list of their papers, pre-prints, or reports published since their participation at ICERM (or, in the case of the five-year follow-up, since their initial two-year survey). Participants then have the

opportunity to include/update publications resulting from their participation in an ICERM program or event. ICERM is responsible for finding and compiling these publications for each participant. Additionally, before implementing each survey, ICERM continues to be involved in editing and testing the survey in order to have an end product that will most effectively provide data aligned with its goals.

It is important to note here that although ICERM has hired SRG as its external evaluation company to aid in reaching their evaluation goals, the institute still plays a vital role in the data collection and survey distribution process. In addition, at weekly management meetings, survey results are reviewed and discussed so that improvements can be made as appropriate.

Note: Links to exit survey summaries for core programs run during this reporting cycle (May 1, 2018 through May 10, 2019) can be found in Appendix H.

Reported Scientific Outcomes/Projects Initiated

In the past, the Director sent a request to all long-term participants asking for updates on their research projects and/or publications that arose during, or were enhanced by, participation in an ICERM program. With the advent of ICERM's 2-year and soon to be added 5-year follow-up survey for each of its semester programs, scientific outcomes have begun to be collected much more systematically and consistently; ICERM can now report scientific outcomes for past programs in a standardized report.

For the purposes of this report, we have summarized "projects initiated" that were reported on the Fall 2018 and Spring 2019 semester program exit surveys. Participants answered the question, "What, if any, specific projects did you initiate or continue while attending this semester program?" Using unique IDs, ICERM will be able to track the advancement of these initial projects through the subsequent standardized 2-year and 5-year follow-up surveys.

In general, the response rate for all survey types has remained steady over the past three years, when ICERM first began tracking response rates.

Note: a list of research projects initiated at ICERM during the Fall 2018 and Spring 2019 semester programs can be found in Appendix I.

Corporate and Academic Sponsorship

Several math institutes currently funded by the NSF employ corporate and university-sponsored programs with tiered memberships. ICERM launched its own unique corporate and academic sponsorship programs in 2011.

The Corporate Sponsorship program has a $5,000 annual membership fee. To date, ICERM has received $82,500 in corporate sponsorship funds.

Our current corporate sponsor is:

- Microsoft Research
- Schlumberger

The Academic Sponsorship has an annual membership fee of $1,500 for domestic memberships with small graduate student programs, $3,000 for domestic membership with large graduate student programs, and $5,000 for international membership. To date, ICERM has received $83,375 in academic sponsorship funds.

Academic sponsors include:

- Cornell University, Department of Mathematics
- Indiana University, Bloomington, Department of Mathematics
- Korea Advanced Institute of Science and Technology, Department of Mathematical Sciences
- Michigan Tech, Department of Mathematical Sciences
- Worcester Polytechnic Institute, Mathematical Sciences Department

External Support

The institute staff works to develop new sources of support for its programs. Assistant Director of Finance and Administration, Juliet Duyster, has duties which include managing both public and private grants, managing the proposal process and ensuring that follow-up reporting is completed. Assistant Director Ruth Crane manages relations with the institute's sponsoring corporations and serves as a liaison to Brown's Division of Advancement, which unites Alumni Relations, Development, Corporate and Foundation Relations in a single, focused organization.

In addition to the funding provided by the NSF, ICERM receives substantial in-kind financial support from Brown University. The Director is released from teaching, and two Deputy Directors are released from half of their teaching responsibilities. In addition, ICERM is not charged for the use of its building or for custodial care which Brown values at $670,500. This year Brown gave ICERM over $100,000 ($75K of which is the university operating budget).

Other Funding Support received in 2018-2019

Additional Grants	*Amount*
American Mathematical Society Epsilon Fund	$2,500.00
MSIDI (Blackwell-Tapia)	$34,873.06
Sloan Foundation (Blackwell-Tapia)	$33,500.00
TRIPODS	$ 29,747.68
Sub-total	**$100,620.74**
University Funding Support	
University Research Committee	$75,000.00
Supplemental Administrative Costs	$21,629.40
Brown UTRA Program for Summer@ICERM	$14,000.00
Sub-total	**$110,629.40**
Sponsor Support	
Academic Sponsors	$18,500.00
Corporate Sponsors	$5,000.00

Individual Sponsors	$2,580.00
Sub-total	$26,080.00
TOTAL	**$237,330.14**

"Mathinstitutes.org" Supplemental Funding

ICERM handles ongoing basic maintenance for the www.mathinstitutes.org website. This entails hosting the website on Brown servers, providing technical assistance to other institutes uploading data, keeping the diversity program pages and other resources current, and adjusting the video search interface as needed.

ICERM requested this supplement because the institute had been covering the costs of this work through its core grant. The supplement allows ICERM to be more active in keeping the site current and responsive to our peers as they request changes.

The main advantages of this supplement are that: 1) the NSF can quantify the ongoing cost to maintain the site; 2) ICERM staff are able to take on larger and more complex updates to the video search interface; and 3) ICERM can facilitate improvements to the presentation and organization of the diversity program webpages.

The www.mathinstitutes.org site serves an important role for the Mathematical Institutes program as a whole. This supplement ensures that it evolves to meet the changing needs of each of the institutes and allows ICERM to be pro-active in responding to suggestions from program leadership on how institute activities may best be promoted. ICERM technical staff continues to provide routine maintenance and end user support.

From May 2018 through April 2019, $1,281.74 was spent on staff time. This time was focused on making incremental changes to page layout, such as adjusting the way upcoming events are displayed, modifying content based on feedback from the Institutes Directors, and fixing bugs to improve the accuracy of search results. During this time ICERM staff also updated the underlying software for the joint media database and the website as a whole in order to stay within vendor support parameters.

Diversity and Outreach

Ulrica Wilson, an Associate Professor of Mathematics at Morehouse College, is also ICERM's Associate Director of Diversity and Outreach. Ulrica provides leadership in meeting institutional diversity goals: ensuring diversity throughout ICERM's programs, assisting in the development of policies and procedures, participating in national meetings and conferences, and helping to identify and obtain funding for programs and activities. She chairs the overarching diversity committee of the Mathematical Sciences Institutes Diversity Initiative (MSIDI). In addition, she leads the program 'Research Experiences for Undergraduate Faculty' (REUF), a collaboration of ICERM and the American Institute of Mathematics that supports faculty at four-year institutions that would like to lead research experiences for undergraduates.

ICERM strongly supports the National Science Foundation's goals of expanding the numbers and diversity of individuals engaged in mathematical sciences through increased participation. Through its membership in the Math Institutes Diversity Committee, the institute actively seeks best practices for securing the participation of women and under-represented minorities in ICERM's governing bodies and in all scientific programs, workshops and events. Specifically, ICERM policy includes the following:

In consultation with Dr. Wilson and members of the Scientific Advisory Board (SAB), ICERM's Directors reach out to women and underrepresented minorities to encourage them to submit proposals for workshops and semester programs. When we receive program sketches and pre-proposals, Directors routinely ask organizers to consider women as organizers. When invitations are issued to speakers or long-term program participants, Directors push back if the proposed slates include few women. Similar guidance is offered as postdocs and undergraduate students are evaluated. Directors review each shortlist to ensure it takes ICERM's diversity goals into account.

Directors also promote networking opportunities within workshops and semester programs, e.g., opportunities for women to come together for lunchtime discussions. The ADVANCE program of the Association for Women in Mathematics promotes the development of networking groups and research conferences supporting these networks. ICERM has hosted (or will host) meetings for Women in the Science of Data and Mathematics (WISDM), Women in Symplectic and Contact Geometry and Topology (WiSCon), and a developing network of women in algebraic geometry.

ICERM hosts or co-sponsors special events or conferences that serve women and under-represented minorities in the mathematical sciences, including diversity workshops, Blackwell-Tapia conferences, Society for Advancement of Chicanos and Native Americans in Science (SACNAS) conferences, Association for Women in Mathematics (AWM) workshops and events, and is building relationships with academic institutions that serve large minority populations.

ICERM states its commitment to diversity on all informational and promotional materials, and broadly advertises its activities and opportunities for funding.

Diversity Events in 2018-2019

- Modern Math Workshop at SACNAS, Fall 2018 (San Antonio, TX)
- Mathematical Field of Dreams Conference, Fall 2018 (St. Louis, MO)
- Hosted the Blackwell-Tapia conference and award banquet, Fall 2018 (Providence, RI)

Other Activities

- Continue to share funds among NSF Mathematics Institutes available for rotating programs like Modern Math Workshop and Blackwell-Tapia
- ICERM is a member of the NSF Institute-wide diversity committee
- ICERM co-supporter the AWM mentor network
- GirlsGetMath@ICERM high school math camp (outside funding)
- A networking event for women during the Core Computational Methods workshop
- A LGBTQ lunch during fall 2018 semester program

Outreach Activities

Public Lectures

ICERM has gained a reputation for providing the Brown community and the general public with an excellent public lecture series. During this reporting cycle, 5 public lectures occurred, attracting a broad audience, from high school students on up. In September 2018, 285 people attended "How to be Human in the Age of Algorithms", featuring Hannah Fry (UCL). In November 2018 in conjunction with the Blackwell-Tapia conference, 91 people attended "Mathematics: Rhyme and Reason", featuring Mel Curie (NSA, retired). In February 2019, 130 people attended "Discovering Black Holes and Gravitational Waves: Algorithms and Simulation", featuring Scott Field (UMass Dartmouth). In March 2019, 124 people attended "Bias in Bios: Fairness in a High-stakes Machine-learning Setting", featuring Adam Tauman Kalai (Microsoft Research New England). In May 2019, Dr. Steven Strogatz (Cornell Unviversity) gave his talk "What's the big deal about calculus?" to 150 people.

GirlsGetMath@ICERM

For the past 5 years, ICERM has been able to secure funding to run its well-received GirlsGetMath@ICERM program.

GirlsGetMath Is designed to address the underrepresentation of women in STEM fields, seeks to motivate young women to consider careers in mathematics, computation, and quantitative fields, and provides an affirming female environment that encourages participants to explore, and invites them to excel in, the mathematical sciences.

The program inspires 20-25 participants to love math by:

- demonstrating through hands-on activities, games, and computer simulations that the study of mathematics can be exciting, fun, and useful;
- introducing the high school participants to a variety of career opportunities for which sophisticated mathematical ability plays a key role, with an emphasis on the central role mathematics plays for success in STEM careers; and
- providing the participants with a support group of like-minded peers and mentors.

GirlsGetMath Broader Impact

The mentorship provided to the participants has been specifically designed by those with experience in outreach to meet a key set of needs identified by research as being most likely to make a difference in the way the girls view mathematics and STEM disciplines. The program content is created by mathematicians who collectively have many years of experience as researchers and educators. It is crafted to be at the appropriate level for the participants, but at the same time challenging and practical. The topics are selected to showcase the beauty and depth of mathematics.

With a recent grant from the JetBlue Foundation, ICERM has developed a train-the-trainer program for faculty interested in replicating a GirlsGetMath program at their home institutions; this program will launch in summer 2019; Train-the-trainer participants will have the opportunity to apply for start-up seed funds to run their own program in summer 2020.

ICERM has developed methodologies for tracking GirlsGetMath alumnae annually in order to follow their educational interests – specifically, how many will go on to seek a college degree and if they choose to major in a STEM field. We are already aware that two GirlsGetMath alumnae (from 2014 and 2015) are currently matriculating at Brown University. One has already declared her concentration in Computer Science.

EPSCoR

ICERM supports the National Science Foundation's EPSCoR mission: "to assist the NSF in its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education." EPSCoR goals are:

1. to provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity and competitiveness;
2. to advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation and overall knowledge-based prosperity.

Accepted ICERM participants from EPSCoR States

(May 1, 2018 through May 10, 2019)

EPSCoR State	# of ICERM Participants
Alabama	8
Alaska	1
Delaware	12
Hawaii	1
Iowa	10
Kentucky	3
Louisiana	12
Maine	8
Mississippi	7
Missouri	7
Montana	3
Nevada	3
New Hampshire	10
New Mexico	3
North Dakota	3
Oklahoma	3
Puerto Rico	1
Rhode Island	226
South Carolina	14
Tennessee	28
Utah	11
Vermont	1
Wyoming	1

Administration and Staff

The ICERM Directors who received funding from the NSF core grant during this reporting cycle were Carolyn Klivans and Homer Walker. Brendan Hassett commits 100% time.

ICERM Staff

Finance Team

Juliet Duyster, Assistant Director of Finance and Administration, hired in August 2011: reports to the Assistant Director. Oversees all business operations such as financial management and services, including budgets, reports, contracts, stipends, human resources, and visa issues. Coordinates the development of new proposals, teaching buyouts for program leaders, and advises the Director on the resources available for specific scientific programs. Manages the finance staff.

Nina Succi, Coordinator of Finance and Administration, hired February 2016: reports to the Financial Manager. Serves as fiscal liaison and primary point of contact for ICERM staff, program organizers, visitors, postdocs, students, customers, and vendors for all financial transactions and related issues. Processes all participant reimbursements and payments made to vendors; assists with human resources and administrative support.

Events Team

Jenna Sousa, Program Manager hired May 2014: reports to the Assistant Director. Provides project management and logistical oversight for ICERM's complex portfolio of research programs and events. This includes the oversite of all applications, invitations, housing, program schedules, special events, and exit surveys. Manages the event staff.

Teresa Fitzenry, Program Coordinator, hired October 2016: reports to Program Manager. One of two Program Coordinator positions. Coordinates all logistical aspects of the fall semester/later summer programs and workshops. Acts as the main point of contact and customer support for ICERM visitors; sends and tracks speaker invitations, coordinates visitor housing, orders office supplies, and enters participant data into ICERM's Cube database. Assist the Program Manager and Assistant Director with other activities, such as social media and other marketing, as needed.

Kellie Shaughnessy, Program Coordinator, hired February 2017: reports to Program Manager. One of two Program Coordinator positions. Coordinates all logistical aspects of the spring semester/early summer programs and workshops. Acts as the main point of contact and customer support for ICERM visitors; sends and tracks speaker invitations, coordinates visitor housing, orders office supplies, and enters participant data into ICERM's Cube database. Assist the Program Manager and Assistant Director with other activities, such as social media and other marketing, as needed.

IT Team

Brian Lavall, Senior Systems Administrator, hired April 2014: reports to the Director of IT. Oversees support and administration of all ICERM A/V technologies, hardware and software systems. Coordinates the development of ICERM's website and video database. Monitors and

actively controls the Echo 360 lecture capture system and provides first level support for technical issues such as wireless connectivity and printing.

Bernadette McHugh, Web and Communications Coordinator, hired in September 2012: reports to the Director of IT. Updates and maintains website content, web-based applications, and social media used to support and promote ICERM and its activities. Provides A/V support for the institute's workshops and events.

Tori Santonil, Application Developer, hired June 2016: reports to the Director of IT. One of two Application Developer positions. Performs application testing, development, and maintenance, including development/coding, testing, and ongoing maintenance of the department's front-end applications, back-end applications, java application servers, and databases.

Application Developer (open position).

ICERM PI and Director Biographies

Brendan Hassett (Director) joined the Brown faculty the summer of 2015 as a Professor of Mathematics. He assumed the directorship of ICERM in July 2016. Brendan received his Ph.D. from Harvard in 1996 and then spent four years at the University of Chicago before joining the faculty at Rice University in 2000. He was the chair of the mathematics department at Rice from 2009 to 2014. He has also held visiting positions at the Mittag-Leffler Institute in Stockholm, the Chinese University of Hong Kong, and the University of Paris. Brendan's research focus is algebraic geometry - the study of geometric objects that are defined as solutions to polynomial equations. Brendan has written more than 50 research papers and has authored or co-edited six books. His work has been recognized with a Sloan Research Fellowship, a National Science Foundation CAREER award, and the Charles W. Duncan Award for Outstanding Faculty at Rice. He is a Fellow of the American Mathematical Society.

Mathew Borton was one of ICERM's first employees, hired in December 2011. As the IT Director, he brings big-picture, strategic development skills to the institute. He oversees all daily IT/technology related operational activities and ensures IT security and stability. He acts as the liaison to the Brown University's IT community. Besides supporting the scientific activities within the institute, his responsibilities include overseeing the support of administrative IT and A/V equipment, and the development and support of key web interfaces and databases. Mat received his BS in Information Technology and his MS in Technology – Information Security, both from Purdue University.

Jeffrey Brock is a Professor of Mathematics and the Dean of Science at Yale University. He is the founding director of the Data Science Initiative at Brown University, as well as an ICERM Associate Director. Jeff's research focuses on low-dimensional geometry and topology, particularly on spaces with hyperbolic geometry. He received his undergraduate degree in mathematics at Yale University and his Ph.D. in mathematics from U.C. Berkeley, where he studied under Curtis McMullen. After holding postdoctoral positions at Stanford University and the University of Chicago, he came to Brown as an Associate Professor. He was awarded the Donald D. Harrington Faculty Fellowship to visit the University of Texas, and has had continuous National Science Foundation support since receiving his Ph.D. He was awarded a

John S. Guggenheim Foundation Fellowship in 2009 and was recently elected Fellow of the American Mathematical Society. He rotated off as ICERM Associate Director in June of 2018.

Ruth Crane, Assistant Director, joined ICERM in November 2010 as the institute's first employee. She has over 35 years of communications and management experience, ranging from corporate training, health care, and academia. She uses her broad range of experience in order to act as chief-of-staff and oversees the coordination and administrative aspects of all the research programs of the institute. She is the liaison for the institute's fundraising activities and coordinates grant proposals, including proposal writing. Ruth manages all ICERM marketing and oversees ICERM's web content as well as community outreach activities. She works closely with the director and the institute's boards. Ruth received her BS from Emerson College.

Sigal Gottlieb is a Deputy Director at ICERM, and a Professor of Mathematics and founding co-Director of the Center for Scientific Computing and Visualization Research (CSCVR) at UMass Dartmouth. She is a Fellow of the Society of Industrial and Applied Mathematics. Sigal graduated from the Division of Applied Mathematics at Brown University (ScB'93, ScM'95, PhD'98). Her research interests include numerical analysis, scientific computing, and high-performance computing. Specifically, the high-order numerical methods for simulation of hyperbolic PDEs with shocks. These methods include WENO, spectral, and pseudo spectral methods, as well as strong stability preserving time discretizations. She is best known for her contributions to the field of high order time-stepping for hyperbolic PDEs, and her research in this area has been funded by the AFOSR continually since 2006; she is currently a PI on an AFOSR grant "High Order Strong Stability Time Discretizations Beyond the Method-of-Lines Framework". Sigal is also interested in reduced basis methods for solving PDEs with many parameters, and is co-PI with Yanlai Chen on NSF grant "Rigorous Development of an Efficient Reduced Collocation Approach for High-Dimensional Parametric PDEs". Recently, Sigal led a team of computational scientists at the CSCVR to obtain a $643,899 DURIP grant from the ONR to fund a new shared cluster at UMassD.

J. Elisenda Grigsby is a Deputy Director at ICERM, and a Professor in the mathematics department at Boston College. Her background is in low-dimensional topology, and she uses categorified invariants to study braids, links, and the surfaces they bound in the three-sphere and the four-ball. Eli's work connects and unifies structures in geometric, symplectic, and contact topology, homological algebra, and representation theory. Her research has been funded by the National Science Foundation and the Simons Foundation. In 2015, she was the inaugural winner of the AWM-Birman Research Prize in Topology and Geometry, and in 2016 she was awarded the Presidential Early Career Award for Scientists and Engineers (PECASE) by President Obama. Eli received her PhD from UC, Berkeley in 2006 and has since held visiting research positions as an NSF postdoctoral scholar at Columbia from 2006-2009, a Viterbi-endowed postdoctoral scholar at MSRI (Berkeley, CA) in Spring 2010, and a Simons foundation fellow at the Newton Institute (Cambridge, UK) in Spring 2017.

Jeffrey Hoffstein is a Professor of Mathematics at Brown University, and an ICERM Consulting Director. He received his PhD in mathematics from MIT in 1978. After holding postdoctoral positions at the Institute for Advanced Study, Cambridge University, and Brown University, Jeff was an Assistant and Associate Professor at University of Rochester. He came to Brown as a full

professor in 1989. His research interests are number theory, automorphic forms, and cryptography. Jeff has written over seventy papers in these fields, co-authored an undergraduate textbook in cryptography, and jointly holds seven patents for his cryptographic inventions. He was a co-founder of Ntru Cryptosystems, Inc., now named OnBoard Security.

Jill Pipher is the Elisha Benjamin Andrews Professor of Mathematics at Brown University and ICERM's founding Director Emeritus. She is Brown University's Vice President for Research. Pipher served as Chair of the Mathematics Department 2005-2008. Jill received her Ph.D. from UCLA in 1985 and came to Brown as an Associate Professor in 1990 from the University of Chicago. Her research interests include harmonic analysis, partial differential equations and cryptography. She jointly holds four patents for the NTRU encryption and digital signature algorithms and was a co-founder of Ntru Cryptosystems, Inc., now named OnBoard Security. Her awards include an NSF Postdoctoral Fellowship, Presidential Young Investigator Award, Mathematical Sciences Research Institute Fellowship, and an Alfred P. Sloan Foundation Fellowship. She served as President of the Association for Women in Mathematics in 2011-2013 and was a National Women's History Month 2013 Honoree. She was honored to deliver the 2016 Brown University Presidential Faculty Award lecture. Jill also serves as the president of the American Mathematical Society. Jill is a Fellow of the American Mathematical Society and a member of the American Academy of Arts and Sciences.

Caroline Klivans is an Associate Professor of Applied Mathematics at Brown University, and an ICERM Associate Director. Her focus is on the Institute's mentoring and professional development programs for students and postdoctoral fellows. In particular she leads the Round-Table discussion sessions building community and career foundations. Caroline received a BA degree in mathematics from Cornell University and a PhD in applied mathematics from the Massachusetts Institute of Technology. Before coming to Brown, she held positions at MSRI and the University of Chicago. Her research is in algebraic, geometric and topological combinatorics.

Bjorn Sandstede is Professor of Applied Mathematics, a Royce Family Professor of Teaching Excellence, the Director of the Data Science Initiative at Brown University, and an ICERM Associate Director. He studied mathematics at the University of Heidelberg and received his PhD in 1993 from the University of Stuttgart. After holding postdoctoral positions at the Weierstrass Institute in Berlin and at Brown University, he was a faculty member at the Ohio State University from 1997-2004, before moving in 2004 to the University of Surrey in England. In 2008, he joined the Division of Applied Mathematics at Brown University. Bjorn received an Alfred P Sloan Research Fellowship in 2000, was awarded the first JD Crawford Prize of the SIAM Activity Group on Dynamical Systems in 2001, received a Royal Society Wolfson Research Merit Award in 2004, the Elsevier Jack Hale Award, and Brown's Philip Bray Award for Teaching Excellence and the Graduate School Faculty Award for Advising and Mentoring. He was selected as a Fellow of the Society for Industrial and Applied Mathematics.

Homer Walker was a Professor of Mathematics at Worcester Polytechnic Institute 1997-2018 (now emeritus) and previously held faculty appointments at Utah State University, the University of Houston, and Texas Tech University. He is currently a Consulting Associate Director for ICERM after having served as Deputy Director for several years. Homer has held visiting appointments at a number of institutions, including Cornell, Yale, and Rice Universities and

Lawrence Livermore and Sandia National Laboratories. His previous administrative experience includes service as department head at WPI 1997-2002 and as program manager for the US Department of Energy Office of Science Applied Mathematics Program 2007-2008. Homer's research interests are in numerical analysis and computational mathematics, especially iterative methods for large-scale linear and nonlinear systems, implementations for high-performance computing, and applications. He was a long-term associate editor of SIAM Journal on Numerical Analysis and and a guest editor for ten special sections in SIAM Journal on Scientific Computing. He has also served on program committees for a number of national and international conferences and workshops, notably the biennial Copper Mountain Conferences on Iterative Methods, as well as on many review panels and site-visit teams for funding agencies in the US and abroad.

Ulrica Wilson is an Associate Professor of Mathematics at Morehouse College. As ICERM's Director of Diversity and Outreach, she provides leadership in meeting institutional diversity goals: ensuring diversity throughout ICERM's programs, assisting in the development of policies and procedures, participating in national meetings and conferences, and helping to identify and obtain funding for programs and activities. Ulrica's primary research has been in noncommutative ring theory and combinatorial matrix theory. Throughout her career, she has integrated opportunities to address diversity issues in the mathematical workforce. A decade of experience includes directing the Enhancing Diversity in Graduate Education EDGE Program and Research Experience for Undergraduate Faculty REUF workshops at AIM and ICERM. Ulrica was recently named as a 2019 AWM Fellow for her work supporting the professional development of women pursuing careers in the mathematical sciences.

Facilities

ICERM is located on the 10th and 11th floors of 121 S. Main Street, in a Brown owned building in downtown Providence, RI. Visitors to ICERM are within a 10-minute walking distance of the Brown campus, the train station, major hotels, and a variety of restaurants and historic sites.

The space includes a 100-seat lecture hall, a 20-seat seminar room, a 20-seat conference room, an administrative suite, office space for 40-45 visitors, two kitchens, and three large collaborative areas.

IT Resources

ICERM's information technology group's mission is to provide the necessary tools for research, collaboration, and information dissemination required by the institute's participants and to support the administrative staff. This is accomplished by providing flexible systems that can be quickly reconfigured to meet research needs and efficient administrative tools that allow the institute's staff to maintain operational excellence.

Work Stations

ICERM provides virtual desktop systems to all semester program participants using a custom VNC connection to the Center for Computation and Visualization. The host operating system is Redhat Linux Server, the guests use Redhat Linux workstation, and the client machines are thin clients using a thin version of Debian. Applications are distributed based on the needs of the

current program and researcher requests. Applications are distributed as needed. Application needs differ from program to program and researcher to researcher. Individuals have administrative control over their own virtual desktops. Researchers are also free to provide their own equipment or use their own laptop. The majority of the applications provided to users will leverage existing Brown license agreements.

Web Based Tools

ICERM provides web-based tools for collaboration and to assist research. All previous talks and papers generated in the course of semester programs are archived and available for download and review via the website.

Multimedia Resources

ICERM has state of the art audio/visual capabilities. The 120-seat lecture hall features dual projection screens, a centrally controlled AV system capable of displaying multiple media types, and a lecture capture system with an auto-tracking camera for recording presentations and streaming to the web. A smaller meeting room is equipped with a video conferencing system and includes a digital media projection system. The video conferencing system can also be leveraged to communicate with the lecture hall. A seminar room on the 10th floor provides basic multimedia presentation capability. Digital signage screens throughout the institute are used to display important information to visitors and can be independently used as a peripheral display from a laptop.

Live Streaming

ICERM provides live, real-time video streaming of all Workshop talks, special events, and tutorial sessions given in the lecture hall.

Video Archives

ICERM digitally records semester and topical workshop talks and special lectures in High Definition using the Panopto lecture capture system. Presentations are then archived and made available for viewing on our website along with a PDF copy of the presenter's slides, when available.

Data Collection and Reporting

ICERM has a visitor management system called CUBE to collect and report on participant data. This system will become a central point of data management for both staff and participants as new feature sets are added.

Brown Computing Resources

ICERM participants are encouraged to use other IT resources available at Brown. Chief among these is the high-performance computing cluster hosted by the Center for Computation and Visualization. ICERM provides premium access accounts upon request to all long-term participants and to workshop participants on an as needed basis with approval from the Director.

Participants are also welcome to use the Digital Scholarship Lab at the Rockefeller Library. This room incorporates a high-definition video wall for large-scale visualization and collaboration.

CCV makes other services available to ICERM participants, including access to consultants for code creation and optimization and an immersive display environment.

APPENDIX:

Appendix A: Sample Semester Schedule & Organizer Timeline
Appendix B: Upcoming Programs and Events
Appendix C: Collaborate@ICERM Summary Reports
Appendix D: Minutes from Board of Trustees Meeting
Appendix E: Minutes from Scientific Advisory Board Meetings
Appendix F: Minutes from Education Advisory Board Meeting
Appendix G: MIDs Meeting Minutes
Appendix H: Survey Summaries May 1, 2018-May 10, 2019
Appendix I: Projects Initiated at ICERM 2018-2019
Appendix J: ICERM Income and Expenditure Report (NSF Required)