

Institute for Computational and Experimental Research in Mathematics

Annual Report May 1, 2022 – April 30, 2023

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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

The following grid lists ICERM's scheduled programs and events from May 1, 2022 through April 30, 2023 supported by the core NSF award and other grants. All programs and events were in person with the option for virtual attendance as well. The grand total of "Unique Visits" during this timeframe was **1,215** for both in person and virtual attendees. There were 950 in person attendees and 266 virtual attendees. The "Unique Visits" total for *just ICERM's core programs* was **1,104** (not including Hot Topics – see note below the grid). There were 886 in person attendees and 240 virtual attendees. While virtual participation is lower than the previous two reporting cycles, those cycles were impacted by the pandemic when most programs were either virtual or hybrid and many researchers were attending more programs as a result. In person visits have not recovered to our pre-pandemic peaks, yet we are seeing a steady increase in attendance.

For reporting purposes, a visit is defined as "A contiguous period of time that a person is physically at or virtually interacting with ICERM" based on known arrival and departure dates, without reported gaps. The "Total #" column includes individuals who attended multiple events within a set period of time. An example is long-term visitors who attended several workshops during a semester program. The public lectures list the number of people registered to attend.

ТҮРЕ	TITLE	START Date	END Date	# UNIQUE ATTENDED	Total Attended
Collaborate@ ICERM	Stochastic Theory for Data-Driven Paleoecosystem Models	9-May-22	13-May-22	5	5
Collaborate@ ICERM	The Energy Strip for Codes in Polynomial Metric Spaces	9-May-22	13-May-22	5	5
Collaborate@ ICERM	Higher Fano Manifolds	9-May-22	13-May-22	6	6
Hot Topics Workshop	Topological and Dynamical Analysis of Brain Connectomes	14-May-22	15-May-22	35	35
Collaborate@ ICERM	Moduli of I-Surfaces Via Wall Crossing	16-May-22	20-May-22	5	5
Collaborate@ ICERM	Explicit Galois Representations of Genus 2 Curves	16-May-22	20-May-22	6	6

Reunion Event	Spring 2020 Reunion Event	23-May-22	10-Jun-22	29	29
Collaborate@ ICERM	Improvements to Algorithms Around S-Unit Equations	23-May-22	27-May-22	6	6
Collaborate@ ICERM	Practical Computation with Infinite Linear Groups	6-Jun-22	10-Jun-22	5	5
Collaborate@ ICERM	Algebraic Combinatorics of Weighted Oriented Graphs	6-Jun-22	10-Jun-22	4	4
Collaborate@ ICERM	Arithmetical Structures on Graphs	6-Jun-22	10-Jun-22	4	4
Reunion Event	Summer@ICERM 2020 Reunion Event	9-Jun-22	10-Jun-22	23	23
Special Event	ICM-Day@ICERM	10-Jun-22	10-Jun-22	3	3
Extended Program	Data Science and Social Justice: Networks, Policy, and Education	13-Jun-22	8-Jul-22	26	26
Topical Workshop	Prediction and Variability of Air-Sea Interactions: the South Asian Monsoon	13-Jun-22	15-Jun-22	25	25
Summer@IC ERM	Summer@ICERM 2022: Computational Combinatorics	13-Jun-22	5-Aug-22	31	31
Extended Program Workshop	Interdisciplinary Network Analysis Methods for Analyzing Social Systems	27-Jun-22	1-Jul-22	31	55
Topical Workshop	Lean for the Curious Mathematician 2022	11-Jul-22	15-Jul-22	66	66
Collaborate@ ICERM	Configuration spaces of graphs and moduli spaces of tropical curves	11-Jul-22	15-Jul-22	4	4
Collaborate@ ICERM	Impartial Achievement and Avoidance Games for Generating Finite Groups	11-Jul-22	15-Jul-22	5	5
Collaborate@ ICERM	PSL(2; F) Representations of Homology Spheres	11-Jul-22	15-Jul-22	3	3
Collaborate@ ICERM	Topological Applications of Khovanov Homology and Related Link Homologies	18-Jul-22	22-Jul-22	4	4
Collaborate@ ICERM	Experimental Validation of Observed Principles of Optimal Deep Networks	18-Jul-22	22-Jul-22	4	4
Reunion Event	Fall 2020 Reunion Event	25-Jul-22	12-Aug-22	30	30
Reunion Event	Numerical Relativity Community Summer School	8-Aug-22	12-Aug-22	171	171

Workshop					
Collaborate@ ICERM	Optimal Pots for Tile-Based Self-Assembly of DNA Complexes	8-Aug-22	12-Aug-22	4	4
Collaborate@ ICERM	Quantum Error Correction	15-Aug-22	19-Aug-22	6	6
Collaborate@ ICERM	Modeling Dynamic Behavior in Evolving Networks	15-Aug-22	19-Aug-22	5	5
GirlsGetMath	GirlsGetMath@ICERM: Summer Math Camp for High School Students	15-Aug-22	19-Aug-22	13	13
Semester Program	Harmonic Analysis and Convexity	7-Sep-22	9-Dec-22	57	59
Semester Program Workshop	Opening Event: Harmonic Analysis and Convexity	12-Sep-22	16-Sep-22	0	48
Semester Program Workshop	Harmonic Analysis Methods in Geometric Tomography	26-Sep-22	30-Sep-22	22	72
Semester Program Workshop	Probabilistic Methods in Geometry and Analysis	17-Oct-22	21-Oct-22	50	100
External Event	Modern Math Workshop at SACNAS	25-Oct-22	29-Oct-22	4	4
Semester Program Workshop	Extremal Problems in Harmonic Analysis, Convexity, and Bellman Functions	28-Nov-22	2-Dec-22	43	87
Public Lecture	An ICERM Public Lecture: Mirror Mirror on the Wall: the story of reflection groups and fractal sphere-packings	30-Nov-22	30-Nov-22	69	69
External Event	Summer@ICERM 2022 @ Joint Mathematics Meeting	4-Jan-23	8-Jan-23	14	14
Collaborate@ ICERM	Special Subvarieties of Hypersurfaces	9-Jan-23	13-Jan-23	4	4
Collaborate@ ICERM	Dynamical algebraic combinatorics of permutations, interval closed sets, and knots	9-Jan-23	13-Jan-23	5	5
Collaborate@ ICERM	Point Configurations on Projective Varieties	9-Jan-23	13-Jan-23	4	4
Topical Workshop	Privacy and Ethics in Pandemic Data Collection and Processing	17-Jan-23	20-Jan-23	42	42

Collaborate@ ICERM	Bridging Modeling Modalities and Experimental Data with Equation Learning	23-Jan-23	27-Jan-23	4	4
Collaborate@ ICERM	The stability of pattern-forming fronts in the FitzHugh-Nagumo system	23-Jan-23	27-Jan-23	4	4
Semester Program	Discrete Optimization: Mathematics, Algorithms, and Computation	30-Jan-23	5-May-23	50	51
Semester Program Workshop	Current Themes of Discrete Optimization: Boot-camp for early-career researchers	30-Jan-23	3-Feb-23	20	46
Hot Topics Workshop	Algebraic Geometry in Spectral Theory	24-Feb-23	26-Feb-23	42	42
Semester Program Workshop	Linear and Non-Linear Mixed Integer Optimization	27-Feb-23	3-Mar-23	50	80
Semester Program Workshop	Combinatorics and Optimization	27-Mar-23	31-Mar-23	49	89
Semester Program Workshop	Trends in Computational Discrete Optimization	24-Apr-23	28-Apr-23	35	69
Public Lecture	An ICERM Public Lecture: A Polyhedral Invitation to Mathematics	26-Apr-23	26-Apr-23	83	83

Note: The Hot Topics workshops are fully funded by a Simons Foundation Targeted Grant to Institutes.

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. NOTE: "funded" refers to participants who had offered funding attached to their attendance (some before COVID).

ICERM Funded Participants

		2	SC		Extende	d Progra	m '22		Fa	ll Ser	neste	er '22			Spri	ng Se	emest	ter '2	3	Т	opica	l '22 -	'23
	Program Type	Summer@ICERM 202	22 Collaboration Group	3 Reunion Events	Extended Program	Workshop 1	% of # Reporting	Semester Program	Workshop 1 (opener)	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop Opener	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop A	Workshop B	Workshop C	% of # Reporting
	Total Participants	29	100	121	24	19		49	0	18	37	30		48	15	42	37	25		14	36	13	
	Female	13	50	33	11	8	50%	17	0	4	5	7	31%	12	4	12	11	5	33%	3	5	1	18%
l icit	Self-Identified Gender	2	1	1	0	2	5%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	2	0	4%
Eth	# Reporting Gender	27	92	117	22	16		44	0	12	26	26		44	13	31	29	18		10	32	7	
pre	African American	1	1	1	6	0	15%	0	0	1	2	2	5%	1	0	0	2	0	2%	0	1	1	4%
Gender and E	American Indian	0	0	1	1	0	3%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
gend	Asian	7	17	45	2	7	23%	6	0	5	9	4	24%	12	3	9	7	5	27%	7	1	0	18%
	Hispanic	7	8	5	7	1	20%	3	0	0	3	1	7%	6	3	6	1	3	15%	0	4	2	13%
	# Reporting Ethnicity	26	89	108	24	16		35	0	14	27	24		41	13	30	29	18		9	29	7	
	US - Midwest	1	26	8	5	3	19%	14	0	3	7	3	20%	7	0	5	1	0	8%	1	6	2	14%
.E	US - Northeast	17	26	40	6	5	26%	5	0	4	11	4	18%	9	5	12	10	6	25%	5	10	7	35%
Ö	US - South	2	12	23	5	3	19%	6	0	2	4	6	13%	3	1	5	4	4	10%	0	0	2	3%
t of	US - West	8	18	15	8	4	28%	3	0	0	5	4	9%	5	4	7	2	8	16%	5	1	1	11%
Poir	Africa	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
ical	Asia	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
aph	Canada	0	0	1	0	0	0%	3	0	5	1	3	9%	2	0	2	2	2	5%	0	2	0	3%
Ligo	Europe	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
ق	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%
	Oceania	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%

All Participants (ICERM funded and Non-ICERM funded)

						ded Prog	ram '22		Fa	ll Sen	neste	er '22			Spri	ng Se	mest	3	Topical '22 - '23				
	Program Type		22 Collaboration Groups	3 Reunion Events	Extended Program	Workshop 1	% of # Reporting	Semester Program	Workshop 1 (opener)	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop Opener	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop A	Workshop B	Workshop C	% of # Reporting
	Total Participants	31	102	253	26	31		57	0	22	50	43		50	20	50	49	35		25	66	42	
~	Female	13	52	59	11	14	50%	19	0	4	8	9	28%	12	4	12	14	7	29%	5	15	8	28%
nicit	Self-Identified Gender	2	1	2	0	3	6%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	2	0	2%
Eth	# Reporting Gender	29	94	243	24	26		51	0	16	37	39		46	16	39	40	26		17	58	25	
and	African American	1	0	1	6	2	16%	0	0	1	2	2	4%	1	1	0	2	0	2%	0	1	1	2%
der	American Indian	0	0	1	1	0	2%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
Gene	Asian	7	0	111	2	7	18%	8	0	6	14	6	26%	14	4	13	12	8	32%	9	7	5	23%
Ũ	Hispanic	9	0	13	8	3	22%	5	0	1	3	1	8%	6	5	7	1	5	15%	2	9	3	15%
	# Reporting Ethnicity	28	3	222	26	24		42	0	17	37	37		43	16	38	39	25		16	51	26	
aphical f Origin	US Based	31	84	131	26	26	91%	36	0	10	38	27	65%	26	15	33	26	23	60%	17	38	38	70%
Geogra Point o	Foreign Based	0	18	122	0	5	9%	21	0	12	12	16	35%	24	5	17	23	12	40%	8	28	4	30%

ICERM Funded Speakers

		s		Extende	d Progra	m '22		Fa	ll Sen	neste	r '22			Spri	ng Se	mest	er '23	3	Т	opica	'22 -	'23	
	Program Type	Summer@ICERM 202:	22 Collaboration Group	3 Reunion Events	Extended Program	Workshop 1	% of # Reporting	Semester Program	Workshop 1 (opener)	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop Opener	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop A	Workshop B	Workshop C	% of # Reporting
	Total Participants	20	0	5	0	3		0	0	15	14	15		48	3	22	16	16		9	11	2	
>	Female	10	0	3	0	0	0%	0	0	4	2	4	36%	12	1	3	4	2	29%	3	2	0	33%
nicit	Self-Identified Gender	1	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
Ethi	# Reporting Gender	19	0	4	0	0		0	0	9	7	12		44	2	11	10	9		6	9	0	
nder and Et	African American	1	0	0	0	0	0%	0	0	1	1	0	6%	1	0	0	1	0	3%	0	0	0	0%
der a	American Indian	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
Gender	Asian	6	0	0	0	0	0%	0	0	3	2	1	19%	12	0	2	2	2	24%	4	0	0	27%
	Hispanic	3	0	0	0	0	0%	0	0	0	0	1	3%	6	1	3	0	1	15%	0	1	0	7%
	# Reporting Ethnicity	19	0	4	0	0		0	0	11	9	11		41	2	11	11	9		6	9	0	
	US - Midwest	0	0	1	0	0	0%	0	0	2	1	1	9%	7	0	4	0	0	10%	1	0	0	5%
gin.	US - Northeast	13	0	1	0	1	33%	0	0	4	4	4	27%	9	1	5	5	5	24%	2	4	0	27%
Ori	US - South	2	0	1	0	1	33%	0	0	1	1	3	11%	3	0	1	2	0	6%	0	0	0	0%
nt of	US - West	4	0	0	0	1	33%	0	0	0	3	3	14%	5	0	5	2	6	17%	3	0	1	18%
Poir	Africa	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
ical	Asia	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
eographica	Canada	0	0	0	0	0	0%	0	0	4	0	0	9%	2	0	2	1	1	6%	0	1	0	5%
	Europe	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
Ğ	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%
	Oceania	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%

All Speakers (ICERM funded and Non-ICERM funded)

	22				Extended Program '22				Fa	ll Sen	neste	er '22			Spri	ng Se	emest	3	Topical '22 - '23				
	Program Type	Summer@ICERM 2023	22 Collaboration Group	3 Reunion Events	Extended Program	Workshop 1	% of # Reporting	Semester Program	Workshop 1 (opener)	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop Opener	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop A	Workshop B	Workshop C	% of # Reporting
	Total Participants	22	0	5	0	8		0	0	15	17	15		0	3	22	16	16		9	11	2	
_	Female	10	0	3	0	2	67%	0	0	4	3	4	37%	0	1	3	4	2	33%	3	2	0	33%
licit	Self-Identified Gender	1	0	0	0	0	0%	0	0	0	0	0	0%	0	2	0	0	0	7%	0	0	0	0%
Ethr	# Reporting Gender	21	0	4	0	3		0	0	9	9	12		0	0	11	10	9		6	9	0	
and	African American	1	0	0	0	0	0%	0	0	1	1	0	6%	0	0	0	1	0	3%	0	0	0	0%
der	American Indian	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
jen (Asian	6	0	0	0	0	0%	0	0	3	5	1	26%	0	0	2	2	2	18%	4	0	0	27%
	Hispanic	5	0	0	0	0	0%	0	0	0	0	1	3%	0	1	3	0	1	15%	0	1	0	7%
	# Reporting Ethnicity	21	0	4	0	2		0	0	11	12	11		0	2	11	11	9		6	9	0	
aphical nt of iain	US Based	22	0	3	0	7	88%	0	0	7	12	11	64%	0	1	15	9	11	63%	6	4	1	50%
Geogr Poi	Foreign Based	0	0	2	0	1	2%	0	0	8	5	4	36%	0	2	7	7	5	37%	3	7	1	50%

ICERM Funded Postdocs

Program Type		2	S		Extende	d Progra	ım '22		Fa	ll Sen	neste	r '22			Sprii	ng Se	mest	3	Topical '22 - '23				
		Summer@ICERM 202	22 Collaboration Grou	3 Reunion Events	Extended Program	Workshop 1	% of # Reporting	Semester Program	Workshop 1 (opener)	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop Opener	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop A	Workshop B	Workshop C	% of # Reporting
	Total Participants	2	18	23	2	3		11	0	1	12	5		48	0	1	2	1		5	10	1	
	Female	0	7	3	1	2	60%	5	0	0	3	2	36%	12	0	1	0	0	27%	3	2	0	38%
	Self-Identified Gender	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	2	0	15%
Eth	# Reporting Gender	2	17	22	2	3		11	0	1	11	5		44	0	1	2	1		4	8	1	
pue	African American	0	0	0	0	0	0%	0	0	0	1	2	11%	1	0	0	0	0	2%	0	0	0	0%
jender a	American Indian	0	0	1	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
	Asian	0	6	5	0	1	20%	4	0	0	2	1	26%	12	0	0	2	1	33%	2	1	0	23%
	Hispanic	1	0	0	1	0	20%	0	0	0	3	0	11%	6	0	0	0	0	13%	0	0	0	0%
	# Reporting Ethnicity	2	16	19	2	3		10	0	1	11	5		41	0	1	2	1		4	8	1	
	US - Midwest	0	4	3	0	1	20%	2	0	0	1	2	17%	7	0	0	0	0	13%	1	0	0	6%
.⊑	US - Northeast	1	5	6	1	0	20%	3	0	1	4	0	28%	9	0	0	1	0	19%	2	4	1	44%
Ö	US - South	0	2	3	0	0	0%	2	0	0	2	1	17%	3	0	0	1	0	8%	0	0	0	0%
It of	US - West	1	2	2	1	1	40%	0	0	0	2	0	7%	5	0	0	0	0	10%	2	0	0	13%
Poir	Africa	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
ical	Asia	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
Geographi	Canada	0	0	0	0	0	0%	0	0	0	1	1	7%	2	0	0	0	0	4%	0	1	0	6%
	Europe	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
	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%
	Oceania	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		2	S		Extended Program '22				Fa	ll Ser	neste	er '22			Spri	ng Se	emest	3	Topical '22 - '23				
		Summer@ICERM 202	22 Collaboration Group	3 Reunion Events	Extended Program	Workshop 1	% of # Reporting	Semester Program	Workshop 1 (opener)	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop Opener	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop A	Workshop B	Workshop C	% of # Reporting
	Total Participants	3	18	40	2	8		13	0	1	15	6		10	0	3	2	3		8	17	2	
_	Female	0	7	5	1	2	60%	5	0	0	4	2	32%	3	0	1	0	1	28%	3	5	0	33%
l jicit	Self-Identified Gender	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	2	0	8%
Eth	# Reporting Gender	3	17	39	2	3		13	0	1	14	6		10	0	3	2	3		7	15	2	
and	African American	0	0	0	0	0	0%	0	0	0	1	2	9%	1	0	0	0	0	6%	0	0	0	0%
der	American Indian	0	0	1	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
3en	Asian	0	6	15	0	0	0%	5	0	0	4	1	30%	5	0	0	2	1	47%	3	3	0	26%
Ŭ	Hispanic	2	0	0	1	0	25%	0	0	0	3	0	9%	0	0	0	0	1	6%	1	2	0	13%
	# Reporting Ethnicity	3	16	34	2	2		12	0	1	14	6		9	0	3	2	3		7	14	2	
Geographical Point of Origin	US Based	3	13	20	2	7	90%	9	0	1	12	4	74%	5	0	1	2	0	44%	7	7	2	59%
	Foreign Based	0	5	20	0	1	10%	4	0	0	3	2	26%	5	0	2	0	3	56%	1	10	0	41%

ICERM Funded Graduate Students

Program Type		2	so		Extended Program '22				Fall Semester '22							ng Se	emest	Topical '22 - '23					
		Summer@ICERM 20:	22 Collaboration Grou	3 Reunion Events	Extended Program	Workshop 1	% of # Reporting	Semester Program	Workshop 1 (opener)	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop Opener	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop A	Workshop B	Workshop C	% of # Reporting
	Total Participants	5	4	51	4	6		12	0	5	8	6		12	12	12	9	5		1	4	1	
>	Female	1	0	14	3	3	60%	3	0	1	0	2	19%	4	3	6	4	2	40%	0	1	0	20%
nicit	Self-Identified Gender	1	1	0	0	1	10%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
Eth	# Reporting Gender	5	2	50	4	6		12	0	5	8	6		12	11	12	8	5		1	4	0	
sender and	African American	0	0	1	2	0	20%	0	0	1	0	0	4%	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%
	Asian	1	1	26	0	4	40%	1	0	3	5	0	36%	4	3	5	1	1	32%	0	0	0	0%
	Hispanic	2	0	4	1	0	10%	1	0	0	0	0	4%	2	2	3	0	2	20%	0	1	0	33%
	# Reporting Ethnicity	4	3	46	4	6		8	0	5	7	5		10	11	11	7	5		0	3	0	
	US - Midwest	0	2	2	2	1	30%	3	0	1	4	1	29%	4	0	1	1	0	12%	0	1	0	17%
.E	US - Northeast	2	1	21	0	1	10%	1	0	1	3	0	16%	2	4	4	2	1	26%	1	2	1	67%
Oui	US - South	0	0	6	2	1	30%	2	0	2	1	1	19%	1	1	2	0	2	12%	0	0	0	0%
t of	US - West	3	1	7	0	2	20%	0	0	0	0	1	3%	3	4	1	1	1	20%	0	1	0	17%
Poir	Africa	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
ical	Asia	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
Geographi	Canada	0	0	1	0	0	0%	0	0	1	0	1	6%	0	0	0	1	1	4%	0	0	0	0%
	Europe	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
	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%
	Oceania	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			s		Extend	ded Prog	ram '22		Fa	ll Ser	neste	er '22			Spri	ng Se	emes	Topical '22 - '23					
		Summer@ICERM 202	22 Collaboration Group	3 Reunion Events	Extended Program	Workshop 1	% of # Reporting	Semester Program	Workshop 1 (opener)	Workshop 2	Workshop 3	Workshop 4	% of # Reporting	Semester Program	Workshop Opener	Workshop 1	Workshop 2	Workshop 3	% of # Reporting	Workshop A	Workshop B	Workshop C	% of # Reporting
	Total Participants	5	5	132	4	7		14	0	5	11	9		14	16	16	15	11		4	5	3	
	Female	1	1	32	3	3	60%	4	0	1	0	4	23%	4	3	6	5	3	32%	1	1	0	20%
nicit	Self-Identified Gender	1	1	1	0	1	10%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
Et	# Reporting Gender	5	3	130	4	6		14	0	5	11	9		14	13	16	13	10		3	5	2	
and	African American	0	0	1	2	0	20%	0	0	1	0	0	3%	0	1	0	0	0	2%	0	0	0	0%
der	American Indian	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0	0	0%	0	0	0	0%
3en	Asian	1	2	66	0	4	40%	1	0	3	6	0	30%	6	3	8	4	4	40%	0	0	1	13%
	Hispanic	2	0	10	1	0	10%	3	0	0	0	0	9%	2	4	4	0	3	21%	1	1	0	25%
	# Reporting Ethnicity	4	4	116	4	6		10	0	5	10	8		12	13	15	12	10		2	4	2	
aphical f Origin	US Based	5	5	59	4	5	82%	8	0	4	11	7	77%	12	13	10	8	8	71%	3	5	3	92%
Geogra Point of	Foreign Based	0	0	73	0	2	18%	6	0	1	0	2	23%	2	3	6	7	3	29%	1	0	0	8%

Additional Participant Data

The charts below display breakdowns of ICERM's confirmed NSF-funded 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.





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.

Notable Accomplishments

Fall 2019 Semester Program

ICERM's Fall 2019 Program "Illustrating Mathematics" had four publications related to the program in the Experimental Mathematics "Special Issue on Illustration and Visualization in Mathematics Research".

Computational Aspects of Discrete Subgroups of Lie Groups Topical Workshop

This topical workshop, held virtually in June 2021, published a proceedings volume edited by the organizers Alla Detinko, Michael Kapovich, Alex Kontorovich, Peter Sarnak, and Richard Schwartz. Manuscripts include "Enumerating Kleinian Groups" (Gabai, Meyerhoff, Thurston, and Yarmola), "Compact components of planar surface group representations" (Goldman), and "Geometric algorithms for discreteness and faithfulness" (Kapovich). It appeared in the Contemporary Mathematics series of the AMS.

Fall 2022 Semester Program

October 17-21 ICERM hosted the workshop "Probabilistic Methods in Geometry and Analysis", part of our seminar program "Harmonic Analysis and Convexity". Topics include approximations of convex bodies by polytopes generated by random points on the boundary, statistical properties of random projections of high-dimensional convex bodies, randomized embeddings of graphs, tools for quick estimates of volumes of polyhedra, slicing problems (possible volumes of linear slices of a convex body of unit volume), and applications of projective geometry to differential privacy.

The workshop "Extremal Problems in Harmonic Analysis, Convexity and Bellman Functions" was the final event of the semester program Harmonic Analysis and Convexity. It was a successful meeting during which many future collaborations were established, and exciting new results were shared. Many participants observed that even the talks which had to be delivered remotely felt almost "in person", citing the excellent equipment in ICERM's lecture hall. Wednesday morning's talks by Komla Domelevo (On the dyadic and the continuous Hilbert transform) and Stefanie Petermichl (Continuous time sparse domination and the Bakry Riesz vector in the presence of negative curvature) announced great advances in harmonic analysis and sparked many interesting conversations. The schedule also featured a slate of nine brief "Lightning talks" by early-career researchers. The welcoming environment facilitated many collaborations, especially between senior and junior mathematicians. For example, Alexander Volberg completed several projects with Haonan Zhang (postdoc) and Joseph Slote (graduate student); Polona Durcik and Christoph Thiele had ample time to work and continue a long-standing collaboration.

Spring 2023 Semester Program

ICERM's spring semester program "Discrete Optimization: Mathematics, Algorithms, and Computation" kicked off January 30 with a "bootcamp" for about 40 early-career researchers. It featured minicourses

"Matching Theory and School Choice", Yuri Faenza, Columbia University

"Binary polynomial optimization: theory, algorithms, and applications", Aida Khajavirad, Lehigh University

"Approximation Algorithms for Network Design Problems", Vera Traub, University of Bonn

"Polynomial optimization on finite sets", Mauricio Velasco, Universidad de Los Andes These covered a wide range of mathematical techniques, ranging from graph theory to algebraic geometry. The organizers held an open-problem session to catalyze collaborations, as well as a poster session where graduate students and postdocs could share their research results.

February 27 through March 3, ICERM hosted a workshop "Linear and Non-Linear Mixed Integer Optimization". Mixed-Integer Linear Optimization has been an important topic in optimization theory and applications since the 1960s. It's rich combination of geometry, algebra, number theory, and combinatorics has allowed it to have an enormous impact on real-world applications. But many physical systems have nonlinear aspects and further discrete design aspects, which leads to the paradigm of Mixed-Integer Nonlinear Optimization. Here the mathematics and effective algorithmics are far more daunting than the linear case, and so there is a focus on broad sub-classes where results from the linear world can be lifted up. Furthermore, effective modeling techniques are subtle and intertwined with state-of-the-art algorithmics and software which are rapidly evolving. In addition to 23 lectures from leading figures, the workshop showcased posters from 14 early-career researchers.

In late March, ICERM hosted "Combinatorics and Optimization". Combinatorial optimization has an immense range of applications. This workshop focuses on the mathematical foundations of combinatorial optimization algorithms, in particular regarding the use of algebraic, analytical, and geometric techniques. Special emphasis will be given on polyhedral methods, since they are at the core of several groundbreaking results developed in recent years. In addition to the invited lectures, 10 posters have been accepted from early-career researchers. This event announced two major breakthroughs. Lisa Sauerman (MIT) reported an advance on the "Erdős distance problems": What is the maximum number of unit distances, or the minimum number of distinct distances, respectively, determined by n points in the Euclidean plane? She presented her arXiv preprint "Unit and distinct distances in typical norms", with Agon and Bucić, which considers more general distance functions. Thomas Rothvoss (UWashington) announced new algorithms for deciding whether a convex set in R^n contains a point with integer coefficients. This represents a significant speed-up, improving on 35 years of work on this problem. See the arXiv "The Subspace Flatness Conjecture and Faster Integer Programming" with Reis for details.

Our spring program closed with "Trends in Computational Discrete Optimization" April 24-28, a workshop focused on what the future might look like. A number of speakers from outside academia addressed quantum computation, including Eleanor Rieffel of NASA (A NASA Perspective on Quantum Computing, with Emphasis on Recent Results in Distributed Computing); Ojas Parekh of Sandia National Laboratories (Approximation and Hardness Results for Quantum Max Cut); Carleton Coffrin of Los Alamos National Laboratory (Quantum Annealing and Combinatorial Optimization); and Catherine McGeoch of D-Wave Systems (Milestones on the Quantum Utility Highway). Other themes included the implications of

machine learning for discrete optimization, optimization techniques for neural network verification, and applications of polyhedral geometry to neural network expressivity.

Extended summer programs

One innovation emerging from the pandemic is multi-week summer programs. Before 2022, the only summer event running more than a week was the Summer@ICERM undergraduate research program. In this cycle, we experimented with new models.

Early in the summer, we hosted a three-week reunion event for the spring 2020 semester program "Model and dimension reduction in uncertain and dynamic systems"; this program started in person but moved online in mid-March 2020. The reunion event had a relatively small number of talks but ample time for in-person collaboration among the 29 people in residence. This included an embedded event, a reunion for the 2020 Summer@ICERM program "Fast Learning Algorithms for Numerical Computation and Data Analysis". (Most of its organizers were participants in the spring 2020 semester program.) It was great to give the undergraduate research students an opportunity to connect in person with their peers and mentors.

The second example was the first half of a two-part program "Data Science and Social Justice: Networks, Policy, and Education", which ran June 13 through July 8. This was also a relatively small program, with 26 researchers in residence. The number grew significantly for the embedded workshop "Interdisciplinary Network Analysis Methods for Analyzing Social Systems". This program was innovative, in that the driver for research questions came from real world problems of access and equity, some of which arose from the local community in Providence. The second half of this program will run in summer 2023.

Finally, we offered a three-week reunion for the fall 2020 semester program "Advances in computational relativity". Only a handful of participants were able to come to Providence for the original event due to the pandemic, but 30 people attended the reunion program. The organizers proposed an embedded "Numerical Relativity Community Summer School" that offered a comprehensive introduction to the numerical study of gravitational waves, relativistic fluids, and modified gravity, as well as an opportunity for students and postdocs to interact with senior participants and lecturers of the reunion program.

The overall effect of this programming has been to make summers the busiest time of year at ICERM! In a typical week, we had three or more programs running in parallel, each using different parts of the institute and requiring particular types of staff support.

Workshops

The workshop "Lean for the Curious Mathematician" was held in July 2022. Lean is a proof assistant developed by Leonardo de Moura of Microsoft Research. (He spoke at ICERM.) It aims to formalize and perhaps eventually automate the creation of mathematical proofs. One area of pure mathematics connected with Lean is the Liquid Tensor Experiment. This originates from work of Fields Medalist Peter Scholze and Dustin Clausen. In a 2020 blog post, Scholze issued a challenge to the Lean community: to give a formal proof of one of the most difficult results in

their manuscript. Early success by the Lean community garnered lots of attention, e.g., in a Nature article. The last day of the workshop, Johan Commelin announced the completion of this program. This achievement was marked by a champagne toast at the end of the workshop session.

January 17-20, ICERM hosted the workshop "Privacy and Ethics in Pandemic Data Collection and Processing" in collaboration with Mobility Analysis for Pandemic Prevention Strategies, a research project led by Brown epidemiologist Mark Lurie. It focused on the collection and analysis of large-scale population level and individual mobility and social mixing data, but with an awareness of fundamental ethical questions related to privacy, individual autonomy, consent, and the distribution of power in society. The group addressed new ethical challenges surrounding the collection of health-related data and also explored some concrete methods that can minimize privacy loss and mitigate avenues for social control in this area. Keynotes included

"Modeling epidemics with network data", Samuel Scarpino, Northeastern University "Privacy and epidemic modeling", Katrina Ligett, Hebrew University of Jerusalem "Synthetic data for network modeling", Adam Smith, Boston University

"Key concerns and principles for large-scale data collections and surveillance", Julia Netter, Brown University

"Differential privacy in graphs", Sofya Raskhodnikova, Boston University

"A Forecasting epidemiological patterns using multi-scale semi-mechanistic models", Gerardo Chowell, Georgia State University

"Efficient and scalable multiparty computation", Vlad Kolesnikov, Georgia Institute of Technology

One further event, partly supported by the Simons Foundation, is the workshop "Algebraic Geometry in Spectral Theory". Discrete periodic Schrodinger operators describe the behavior of individual electrons in "ideal" crystals in the tight-binding model of solid state physics. Spectra of such operators have the usual band-gap structure, and the corresponding dispersion relations are algebraic varieties. Recent developments have led to the realization that many open questions in spectral theory may be studied using modern tools in algebraic geometry. These include the relation of reducibility/irreducibility of Bloch and Fermi varieties with physical symmetries of the crystals, the structure of spectral band edges, and Dirac cones. This workshop brought together experts from spectral theory, mathematical physics, and algebraic geometry to understand, apply, and advance these new methods and interactions.

Non-program Specific

In parallel with the "Extremal problems" workshop, ICERM hosted its first in-person public lecture since the pandemic: "Mirror Mirror on the Wall: the story of reflection groups and fractal sphere-packings", by Alex Kontorovich of Rutgers University. Configurations of mirrors can create complex geometry from simple objects; everyone knows how kaleidoscopes generate strange images out of a few colored beads. Mathematicians have classified symmetries arising from reflections, even in large dimensions. Kontorovich unveiled surprising connections with number theory, configurations of mutually tangent circles, and hyperbolic geometry.

Report on ICERM operations

Program Management Team

This reporting period continued to challenge ICERM's program staff, as the institute returned to full in-person operations. Evolving expectations, e.g. for whether speakers would be attending in person and the availability of Zoom alternatives, required flexibility and clear communication. We have limited virtual lectures to 20% of all talks, although we continue to respond flexibly to travel disruptions and health issues. Organizers are asked to decide whether they want to allow virtual participation at all. We have revised our application systems and processes to reflect the full range of options. Changes to ICERM policy and procedure surrounding virtual offerings have made positive strides toward managing the expectations of organizers, speakers, and attendees.

ICERM staff has also been challenged as we facilitate programs and workshops that fall outside our traditionall format. We have pushed the limits of our staff bandwidth and physical space running a variety of concurrent atypical programs over the course of the summer months. This includes extended summer research programs, such as "Data Science and Social Justice", running in parallel with Summer@ICERM, and a variety of topical workshops. ICERM is reviewing ways to balance the needs of all of our programming to provide support equitably.

Information Technology

AV and Video Conferencing

In late summer of 2022 a project was completed to add Zoom room functionality to the 10th floor seminar room. All meeting spaces in ICERM now have remote conferencing capabilities and can host in-person, hybrid or remote sessions. ICERM also has an auxiliary portable AV system To make use of large spaces without integrated AV equipment.

Endpoint Computing

ICERM has moved to an "endpointless" solution for desktop computing due to low participant usage rates. We no longer put terminals/thin clients on each desktop. ICERM now supplies monitors, keyboards and mice for each desk. The IT group maintains a small pool of 15 laptops available for participant use on a temporary basis, as well as an array of cables, connectors and adapters. This strategy optimizes resource allocation by reducing hardware expenditures and maintenance overhead.

Compute and Software Resources

ICERM continues to leverage Brown's resources for software licensing and delivery and for high performance computing. ICERM also provides access to commonly used Software as a Service (SaaS) offerings such as Overleaf and CoCalc. ICERM is augmenting our technology portfolio by supporting commercially available cloud compute resources. These systems will provide the institute with a high level of flexibility and allow us to better support a broader range of programs and participants.

Web Services and Application Development

ICERM continues to iteratively develop Cube, our institute management application, in an effort to minimize administrative overhead for staff, improve the user experience for participants, and enhance reporting capabilities.Recent efforts include:

- Improved UI and workflow for internal staff for application, event, and reimbursement functions.
- Restructured data model to remove reliance on visit dates, increasing speed and flexibility of reporting.
- Created and then deprecated a vaccination attestation form for visitors as required by Brown's operational mandates.
- Added flexibility to publications reporting output and increased public visibility by adding publications listings to ICERM web pages for most program types.
- Updated the reimbursement process to reflect changes to Brown's processes.
- Added functionality to event and application processes to provide more flexibility in meeting program organizer requests.
- Improved security of the application technology stack to mitigate risks to availability and data integrity.

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 fall 2022 annual meeting and a subsequent conference call in June resulted in the selection of semester programs and topical workshops through Spring 2025.

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
- Plan for ensuring the participation of underrepresented groups—As part of your plan please identify a main contact among the organizers that will take the lead in ensuring participation from underrepresented groups. The plan should also list potential participants of the program that are women and potential participants who are members of an underrepresented minority group (African American, Hispanic or Latino, American Indian or Alaskan Native).
- 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 revised proposals is a week prior to the annual November SAB meeting. Once a proposal is accepted, anICERM Director is 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. 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. ICERM research fellow invitations include language regarding Brown University's "Code of Conduct", which addresses sexual harassment, discrimination, and other unprofessional behaviors. Using its Cube database, ICERM tracks demographic information about, and all interactions with, research fellows.

5. Semester Workshops

Semester program organizers recommend organizers for each of the three-to-four workshops, taking into account feedback from ICERM's Scientific Advisory Board and responsible Directors. 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. During this reporting cycle, ICERM updated all of its workshop invitations to include language regarding Brown University's "Code of Conduct", which addresses sexual harassment, discrimination, and other unprofessional behaviors. 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 "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

Program organizers can view the applicants and their supporting documents as well as prioritize them within Cube. A member of the ICERM Directorate reviews the prioritized list, re-ranks as appropriate and makes the final selections, taking into consideration the remaining space in 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 5 Semester postdoctoral fellows (salaried); 60 short-term participants (1-4 weeks); 10-15 graduate students (6+ weeks); and workshop attendees. ICERM helps essential long-term participants negotiate sabbatical leaves or teaching releases to foster their participation.

In response to feedback from the ICERM Board of Trustees, a research fellowship support opportunity was advertised to the mathematical community as well as specific outreach sent to attendees of upcoming programs. The funding is available for fellowships to support faculty who attend one of our semester programs. These are often used to cover teaching release so that participants can be in residence throughout a semester program. We particularly welcomed applications from those not based at R1 research universities and those based at minority-serving institutions, including HBCUs, HSIs, TCUs, and AAPISIs. The program organizers for the relevant program encourage participants to request the support, identify participants whose attendance would be critical to the success of the program, and are consulted to ensure an applicant's background fits with the program. So far this initiative has resulted in 8 applicants for Fall 2023 with 5 being funded and 13 applicants for Spring 2024 with 8 being funded.

Opening, Closing, and Related 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 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 one week and usually consist of 45-50 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
- Early Career 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

2022-2023 Semester Programs

Harmonic Analysis and Convexity

September 7 – December 9, 2022

Organizing Committee:

Javier Gomez Serrano, Brown University

Irina Holmes Fay, Texas A&M University Bo'az Klartag, The Weizmann Institute of Science Alexander Koldobskiy, University of Missouri-Columbia Sergei Treil, Brown University Alexander Volberg, Michigan State University Artem Zvavitch, Kent State University

Program Description:

In recent years, the interaction between harmonic analysis and convex geometry has dramatically increased, which resulted in solutions to several long-standing problems. The program will bring together leading mathematicians in both areas, along with researchers working in related applied fields, for the first-ever long-term joint program.

The main directions of the program will include: the Fourier approach to Geometric Tomography, the study of geometric properties of solids based on information about their sections and projections, Volume and Duality, Bellman technique for extremal problems of harmonic analysis, and various types of convexity of solutions of corresponding Hamilton–Jacobi–Bellman equation, as well as numerical computations and computer-assisted proofs applied to the aforementioned problems. The computational part will cover theoretical aspects (optimal algorithms, and why they work) as well as more applied ones (implementation).

The list of all long-term visitors to the fall 2022 Semester program as well as the participant list for the affiliated workshops can be found in Appendix A.

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.":

- My main direction is theoretical part of Convex Geometry. It was amazing to be able to discuss and (main point) learn computational part of mathematics and think about possible application. On theoretical part it was major advantage for my research to be able to discuss it with young people in my subject and with top researchers in Convex Geometry and Harmonic Analysis.
- I learned cutting edge techniques through the workshops and seminars that have changed how I approached a research problem, and starting collaborations with several participants
- There was quite a diverse group of people present. Apart form the possibilities to have discussions one already profits from the questions from the audience during talks since the group of persons attending is different from "the usual suspects" in one's area of research also the questions are different and therefore stimulating for research.

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

- The highlight was the opportunity to start new collaborations and to have the right environment to make substantial progress on my existing projects and discuss them with other people.
- The work environment at ICERM is exceptionally good. Cordial interactions with staff and participants, great facilities... much more than just attending a conference
- Meeting new researchers. Ability to learn new subjects (Harmonic Analysis and Computations in my case). Outstanding organization ability to work with students and postdoctoral fellows.

Workshop 1: Harmonic Analysis Methods in Geometric Tomography September 26 - 30, 2022

Organizing Committee:

Maria Alfonseca Cubero, North Dakota State University Dmitry Ryabogin, Kent State University Vladyslav Yaskin, University of Alberta Artem Zvavitch, Kent State University

Program Description:

Geometric tomography is the area of Mathematics dealing with the retrieval of information about solid objects based on the size of their sections or projections, or other lower dimensional data. Results from this area often find real-world applications in science and engineering.

In recent years geometric tomography has seen a rapid period of growth due to many exciting developments in harmonic analysis. The goal of the present workshop is to bring together specialists in geometric tomography, harmonic analysis, and related areas to discuss important advances and share new ideas.

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.":

- ICERM gave me an opportunity to meet both the leading specialist and young researchers, who shared with me their results as well as methods they used to obtain them, often devised by themselves. Digging through all their papers on my own to learn all of this, without their throughout explanation and sharing background knowledge, would be impossible.
- There have been two ways how these aims have been achieved. One was by having various personal discussions with several participants of the program. For this it was absolutely crucial to meet in person and enjoy the open atmosphere at ICERM. On specific question that I was discussing with two other participants, we are now very optimistic that we have achieved substantial progress during our stay. The other have been several nicely presented talks on current research topics. This improves and simplifies access to current research topics and led to some new ideas I wish to pursue in the near future.

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

- As a graduate student, I thought this workshop provided me with the great opportunity to interact with some of the peers in my area, which I believe would be very helpful moving forward.
- Hard to pick one thing, The facilities and work environment at ICERM is superb and the atmosphere among participants was very collaborative. I really appreciate having office space despite being here only for 3 weeks (not the case in other places). This is my first conference since Feb 2020, and the experience of discussing in person and meeting new potential collaborators can't be beat. On zoom you don't reach out to people you haven't met before. Several talks gave me and my graduate student promising ideas for current and future research, and with some participants we have started a new project.
- learned new theorems and methods, got to know what scientists all around the world find interesting and what are important problems to be solved, got a very broad and diverse image of what convex geometry really is, made valuable scientific connections

Workshop 2: Probabilistic Methods in Geometry and Analysis

October 17 - 21, 2022

Organizing Committee:

Shiri Artstein-Avidan, Tel Aviv University Ronen Eldan, Weizmann Institute of Science Bo'az Klartag, The Weizmann Institute of Science Mark Rudelson, University of Michigan Ramon van Handel, Princeton University

Program Description:

Probabilistic methods have long played an important role in various areas of geometry and analysis. Notable applications of probabilistic methods appear, for example, in geometric functional analysis, in harmonic analysis, and in discrete mathematics. Conversely, mathematical phenomena of fundamentally geometric and analytic origin, such as the concentration of measure phenomenon, play a central role in modern probability theory. Novel interactions between probability, geometry and analysis continue to drive important innovations in these fields.

The aim of this workshop is to bring together a diverse range of experts from probability, geometry, and analysis, in order to promote further dialogue between these fields and to catalyze the creation of new interactions.

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 learned a lot through the talks, and also through discussing with others during the coffee break. I was advised relevant books and surveys by some speakers i have interacted with, which will enable me to deepen my understanding of the newly learned théories.

Certainly watching the videos again during the next few weeks, with other phd fellows will maintain motivation and help us tackling some of the open questions pointed by the speakers.

- I met a very senior researcher and he suggested a problem that might lead to a good collaboration.
- I have learned several results I was not aware of before, other talks enabled me to put recent results into a broader perspective and get more insight into recently developed methods.

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

- Very good speakers! High level of mathematics mixing Probability, Geometry and Harmonic Analysis. Very friendly and inclusive settings!
- In several talks there was discussed various inequalities on the intersection of convex geometry and probability (like various problems of isoperimetric nature), which is the topic closest for my research and it was great to listen to the talks by the leaders of the field and discuss some details during the breaks.
- met great researchers, among them potential employers for postdoc. I have background both in probability, in harmonic analysis, and in convex geometry. The workshop allowed me to see bridges between these fields. I feel motivated to join people who are already crossing back and forth these bridges.

Workshop 3: Extremal Problems in Harmonic Analysis, Convexity, and Bellman Functions November 28 - December 2, 2022

Organizing Committee:

Javier Gomez Serrano, Brown University Irina Holmes Fay, Texas A&M University Alexander Volberg, Michigan State University

Program Description:

Extremal problems in harmonic analysis recently acquired prominence in questions ranging from optimizers in Fourier restriction results to sharp geometric inequalities to sharp estimates of various singular operators of Calderón–Zygmund type. Sharp inequalities and their stability versions reveal new connections between harmonic analysis, geometric measure theory, additive combinatorics, and stochastic optimal control. There are many examples of sharp estimates by stochastic control approach and the use of special types of convexity and Monge–Ampére equation. There are interesting examples of using the computational tools in proving sharp geometric inequalities for martingales and on Hamming cube and for Fourier restriction inequalities.

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.":

- ICERM did a fantastic job in facilitating my learning of developments within the workshop's topics. This workshop brought together many of the leading researchers in this area and fostered their interactions with each other and with junior researchers. As a junior researcher myself, I feel that this meeting helped me to network with new people, build research connections, and learn about technical advances that I will surely use in my own research.
- As far as computational methodologies go, I learned a great deal about techniques for estimating certain bilinear sums and some techniques for exploiting symmetries to reduce a complicated integral estimate; as for theoretical developments, I learned more about recent progress on boundedness of the convex set-valued maximal operator as well as applications of Fourier analysis to voting systems.

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

- The highlight of the workshop was generally the social interactions and networking opportunities including the reception and coffee breaks. As a junior researcher, these aspects helped me feel comfortable as I integrate into the community.
- This workshop was an amazing opportunity for me to hear talks by individuals that have profoundly contributed to the problems I'm interested in. It was also a great networking opportunity for me, getting to meet similar career stage mathematicians with whom I could possibly collaborate with in the future.
- Meeting a person whose work I am currently studying. They gave a talk related to my current research.

Spring 2022 Semester Program: Discrete Optimization: Mathematics, Algorithms, and Computation

January 30 - May 5, 2023

Organizing Committee:

Jesús De Loera, University of California, Davis Antoine Deza, McMaster University Marcia Fampa, Federal University of Rio de Janeiro Volker Kaibel, Otto-von-Guericke Universität Magdeburg Jon Lee, University of Michigan Laura Sanità, Bocconi University of Milan

Program Description:

Discrete optimization is a vibrant area of computational mathematics devoted to efficiently finding optimal solutions among a finite or countable set of possible feasible solutions.

A famous and classical example of a problem in discrete optimization is the *traveling salesperson problem*: For given cities and distances of traveling from one city to another, we seek to find the shortest route that visits each city once and returns to the starting city. Discrete optimization problems naturally arise in many kinds of applications including bioinformatics, telecommunications network design, airline scheduling, circuit design, and efficient resource

allocation. The field also connects to a variety of areas in mathematics, computer science, and data analytics including approximation algorithms, convex and tropical geometry, number theory, real algebraic geometry, parameterized complexity theory, quantum computing, machine learning, and mathematical logic.

The semester program will explore links between mathematical tools and unsolved fundamental questions in these areas. We plan to explore computational techniques from discrete optimization to experimentally attack classical problems in combinatorics and other areas of pure mathematics. We will also continue the tradition of designing new algorithms for applied and industrial problems which has been part of the subject since its inception. By bringing together a diverse group of researchers, we anticipate making new connections and collaborations as well as deepening existing ones.

The list of all long-term visitors to the spring 2022 Semester program as well as the participant list for the affiliated workshops can be found in Appendix B.

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.":

- My stay at ICERM helped me to learn about the advances related to theoretical and applied elements and approximation methods in discrete optimization. With this I had the opportunity to start new projects and create collaboration links with researchers specialized in these areas. I think it was an excellent event and it has helped to strengthen my knowledge and contributions as well as to expand my areas of research. I am very grateful to the sponsors and organizers, as well as to the other participants.
- For experimental/computational methods, being at ICERM this semester allowed me to start work on applying new computational tools such as mixed integer programming, reinforcement learning, and simulated annealing to the problem of studying monotone diameters of polytopes. From a theoretical viewpoint, I managed to collaborate with some new peers to make progress on the computational complexity of an algorithm called the shadow simplex method. I also began working on a new problem related to the complexity of exact neural network representations of computational problems.
- I haven't had much experience with the applications and computational side it's been great to get to know more of that world and meet people with that expertise.

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

- The highlight was definitely meeting many fantastic researchers in my area and starting many collaborations. The program was instrumental in making the community feel close knit for me. The amount I learned at it was immense and what happened here will guide my research for at least the next three years.
- 1) A great working environment, both for research projects in groups and for focusing on personal work; 2) Intense participation of most attendees in the discussion during both workshops I attended; 3) Ample time for discussion after each talk.
• It was really great to get to know the other grad students and postdocs, I think they will be lifelong friends and colleagues

Workshop 1: Linear and Non-Linear Mixed Integer Optimization

February 27 - March 3, 2023

Organizing Committee:

Pietro Belotti, Politecnico di Milano Marcia Fampa, Federal University of Rio de Janeiro Fatma Kılınç-Karzan, Carnegie Mellon University Jon Lee, University of Michigan Nick Sahinidis, Georgia Institute of Technology Yuan Zhou, University of Kentucky

Program Description:

Mixed-Integer Linear Optimization has been an important topic in optimization theory and applications since the 1960s. As a mathematical subject, it is a rich combination of aspects of geometry, algebra, number theory, and combinatorics. The interplay between the mathematics, modeling, and algorithmics makes it a deep and fascinating subject of applied mathematics, which has had an enormous impact on real-world applications. But many physical systems have nonlinear aspects and further discrete design aspects. So we are naturally led to the paradigm of Mixed-Integer Non-Linear Optimization. But the mathematics and effective algorithmics of this subject are far more daunting than the linear case, and so there is a focus on broad sub-classes where results from the linear world can be lifted up. Furthermore, effective modeling techniques are much more subtle and are intertwined with state-of-the-art algorithmics and software which are rapidly evolving.

This workshop focuses on the latest advances in both areas, Mixed-Integer Linear and Non-Linear Optimization. The workshop is a forum for presenting the latest advances as well as serving as a crucible for new research in these areas.

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.":

- At ICERM I have had the opportunity to learn more about different topics, and both theoretical and computational approaches are very relevant from my point of view. In particular, I think the material related to the fundamentals on related problems and methods helps to find avenues for future research, as well as advanced approaches for those who have more experience.
- The workshop, sponsored by ICERM, has invited people working in both experimental/computational and theoretical developments in mixed-integer linear and nonlinear optimization. The talks gave me some inspiring ideas and interesting questions to work on.

- I think some of talks were amazing and open real deep philosophical questions (e.g., use of field to model inequalities) and showed the limitations of modern ``established'' technology like LP solvers. The best part of all though was to meet and discuss the talks with people IN PERSON.
- I have little background in experimental methodologies, so this event actually let me understand what people are actually doing. It is different from what I thought of before, since I mostly read papers from very applied people, and thought everyone just feed things to a solver and call it a day.

Some Workshop Participant Comments for "Briefly describe workshop highlights"

- I particularly liked the environment at the workshop. There was a good ratio of professors, postdocs, PhD students, and industry professionals, and everyone blended in well at the coffee breaks and the time outside the talks in general. I also think the schedule is well thought of, since it allows for a good balance of talks and time for networking.
- A well combined/articulated set of presentation outlining several directions of research in MINLP. Together with opportunity to share with peers and juniors on latest advances in the domain.
- It was definitely being able to meet and discuss a senior member of my field who worked on a problem I'm working on today 30 years ago. At the workshop, he provided me with a substantial amount of new background on what he did on the topic that will help to guide our future work on the problem here.
- Very relaxed environment with plenty of time for discussing ideas and results with top-notch scholars. Excellent presentations with plenty of theoretical AND practical impact. Great venue with infrastructure for collaborating. Extremely helpful and competent staff.

Workshop 2: Combinatorics and Optimization

March 27 - 31, 2023

Organizing Committee:

Jesús De Loera, University of California, Davis Antoine Deza, McMaster University Volker Kaibel, Otto-von-Guericke Universität Magdeburg Britta Peis, RWTH Aachen University Laura Sanità, Bocconi University of Milan Mohit Singh, Georgia Tech

Program Description:

Combinatorial optimization is an active research field in mathematics, with an immense range of applications. This workshop will bring together researchers and leading experts interested in the mathematical foundations of combinatorial optimization algorithms to discuss new tools and methods, in particular regarding the use of algebraic, analytical, and geometric techniques. Special emphasis will be given on polyhedral methods, since they are at the core of several groundbreaking combinatorial optimization results developed in recent years.

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 talks gave me starting points for new concepts, insights, and methods. Outside of that, listening to various participants discussing with each other taught me a lot of how other mathematicians think of various subjects, including but not limited to my own.
- This workshop had a lot of presentations that discussed approximation algorithms and methods for proving guarantees, which are a very significant area of investigation in my research right now. The processes I was able to observe through these sessions are very helpful to drive my further work.
- ICERM workshop let me the opportunity to attend in person interesting talks on the current topics of the fields and to discuss ideas in person with researchers of the area.

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

- The workshop fundamentally changed how I think about research as a whole. It motivated me to research a lot more, a lot harder, and a lot more happily. Chiefly, it taught me a great deal about how to do things, and I will cherish this information for long. I cannot predict the future, but I believe that for many years I will look back to the past week and consider it one of the most crucial formative experiences of my mathematical life, and more.
- The highlight of the workshop was the interaction with many of the younger participants some of who I had not met before.
- All talks were interesting and having the opportunity to interact with the authors give us, to the attendants, the opportunity to discuss ideas or to clarify questions.
- Gaining an overview of the latest works in my area through talks and conversations. Connecting with other researchers and share ideas/open problems, leading to potential collaboration.

Workshop 3: Trends in Computational Discrete Optimization

April 24 - 28, 2023

Organizing Committee:

Amitabh Basu, Johns Hopkins University Antoine Deza, McMaster University Swati Gupta, Georgia Tech Volker Kaibel, Otto-von-Guericke Universität Magdeburg Giacomo Nannicini, University of Southern California Sebastian Pokutta, Zuse Institute Berlin (ZIB) David Williamson, Cornell University

Program Description:

The aim of this workshop is to discuss many exciting recent developments on the computational side of discrete optimization. The workshop has three main themes. The first theme is that of

commercial and academic/open-source solvers that have allowed the solution of very large-scale problems, and of recent developments in exact solvers that have allowed for proofs of results in logic, knot theory, and combinatorics. The second theme is the interaction between optimization and machine learning: these two areas complement each other in several ways. The third theme is quantum computing and unconventional computing architectures: quantum computing has been used to tackle combinatorial optimization problems, and quantum algorithms exist for other related optimization problems such as linear and semidefinite relaxations.

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 appreciated the interplay of theoretical and computational approaches. One example is taking a polyhedral perspective of artificial neural networks. I do not work directly in machine learning, but I think awareness of such ideas will end up being fruitful in my own research.
- I started at least three new projects, one of which is in an area of interest completely different from what I have done in the past. One of the research ideas has on the back of my mind for many years and finally I had the time and the opportunity to find good collaborators for it.
- The workshop included many talks related to different topics. I had the opportunity to learn more about quantum computing, from the basics to more advanced procedures. Additionally, there were talks related to machine learning techniques used to solve optimization problems or predict solutions based on inputs. Before attending the workshop, I was not very familiar with these topics.
- The hot emerging intereactions of Optimization with Machine Learning AND quantum computing were discussed. It was great! Lots of discussion and excitement.

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

- The highlight for me was getting to meet almost everyone at the workshop and learn about their work. This rarely happens, and even though the workshop was somewhat interdisciplinary, it instilled a sense of community.
- The chance to immerse myself in research questions I am interested in. I worked with several old colleagues and many new ones. the brainstorming sessions were amazing and have led to different directions I look forward to pursuing in the near future. I also like the little library at ICERM where I made it a point to spend an hour every day learning new things.
- Great venue, ample time for discussing research, broad and cutting-edge research topics.
- The fresh timely topics, the healthy respectful debate. Really wonderful.

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 several 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
- Plan for ensuring the participation of underrepresented groups—As part of your plan please identify a main contact among the organizers that will take the lead in ensuring participation from underrepresented groups. The plan should also list potential participants of the program that are women and potential participants who are members of an underrepresented minority group (African American, Hispanic or Latino, American Indian or Alaskan Native).

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 October 1, prior to the annual November SAB meeting, and May 1, prior to a mid-May 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 make additional suggestions as needed.

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 program and outlines the support to be provided. During this reporting cycle, ICERM updated all of its topical workshop invitations to include language regarding Brown University's "Code of Conduct", which addresses sexual harassment, discrimination, and other unprofessional behaviors.

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 on the ICERM website. All applications are stored in the institute's "Cube" database.

6. Applicant Selection

Program organizers can view the applicants and their supporting documents as well as prioritize them within Cube. A member of the ICERM Directorate reviews the prioritized list, re-ranks as

appropriate and makes the final selections, taking into consideration the remaining space in 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 applicants to the workshop may also be supported.

Topical Workshops in 2022-2023

ICERM hosted three topical workshops from May 1, 2022 to April 30, 2023. These workshops focus on topics of current interest in the mathematical sciences.

The list of participants for each of ICERM's 2022-2023 Topical Workshops can be found in Appendix C.

Topical Workshop 1: Prediction and Variability of Air-Sea Interactions: the South Asian

Monsoon June 13-15, 2022

Organizing Committee:

Baylor Fox-Kemper, Brown University Jennifer MacKinnon, UCSD - Scripps Institution of Oceanography Hyodae Seo, Woods Hole Oceanographic Institution Emily Shroyer, Oregon State University Aneesh Subramanian, University of Colorado Boulder Amit Tandon, UMass Dartmouth

Workshop Description:

A challenge for mathematical modeling, from toy dynamical system models to full weather and climate models, is applying data assimilation and dynamical systems techniques to models that exhibit chaos and stochastic variability in the presence of coupled slow and fast modes of variability. Recent collaborations between universities and government agencies in India and the United States have resulted in detailed observations of oceanic and atmospheric processes in the Bay of Bengal, the Arabian Sea, and the Indian Ocean, collectively observing many coupled modes of variability. One key target identified by these groups was the improvement of forecasts of variability of the summer monsoon, which significantly affects agriculture and water management practices throughout South Asia. The Monsoon Intraseasonal Oscillation is a northward propagating mode of precipitation variability and is one of the most conspicuous examples of coupled atmosphere-ocean processes during the summer monsoon. Simulating coupled atmosphere-ocean processes present mathematical challenges spanning numerical methods, data assimilation, stochastic modeling, dynamical systems and chaos, and uncertainty quantification. Predicting monsoon variability is one of the hardest, most important forecasting

problems on earth due to its impact on billions of people, a key aspect of the desire to push weather forecasts into the management-actionable "medium-range" horizon of weeks to seasons. Addressing this challenge requires an interdisciplinary effort to combine observations, computation, and theory. A better understanding of these processes and how they can be represented in a variety of coupled ocean-atmosphere simulations and models (including statistical and dynamical approaches) and forecast systems (including data assimilation techniques and uncertainty quantification) is the primary topic of this workshop. While the set of observations to be discussed will emphasize this region, the mathematical and computational aspects of the program will be significantly broader, covering: coupled ocean-atmosphere modeling for weather models, climate models and idealized models; theory of the atmospheric and oceanic boundary layers, and waves on the interface; data assimilation in coupled modeling systems; and numerical methods for coupled systems.

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 had the opportunity to discuss with experts who work in coupled ocean-atmosphere models at regional and global scales. Their suggestions are beneficial to the coupled smaller-scale LES model that I am constructing.

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

- Variability and air-sea interactions relevant to the South Asian Monsoon were a very interesting topic and several new initiatives taken by different well-established and young scientists are going in the right direction. New methodologies were employed to address mixing problems in ocean modelling.
- The invited presentations covered a wide range of topics from observations to modeling and from small scale turbulence to global scale. It was interesting to discuss with people working from different background but all focusing on the same objective.
- Due to the COVID interruption of our planned week-long workshop, we split our presentations into two parts. The first, purely virtual, set of presentations centered on established scientists with wide audience appeal. The second, hybrid meeting featured primarily early-career presenters, many of whom had worked much of their post-PhD career virtually. For many of these scientists it was their first invited presentation. Thanks to ICERM for giving us the opportunity to hear from these presenters, credit their work over the COVID years, and gather to consider new directions.

Topical Workshop 2: Lean for the Curious Mathematician 2022

July 11 - 15, 2022

Organizing Committee:

Jeremy Avigad, Carnegie Mellon University Kevin Buzzard, Imperial College London Johan Commelin, University of Freiburg Yury Kudryashov, University of Toronto Heather Macbeth, Fordham University Scott Morrison, Sydney University

Workshop Description:

Interactive theorem proving software can check, manipulate, and generate proofs of mathematical statements, just as computer algebra software can manipulate numbers, polynomials, and matrices. Over the last few years, these systems have become highly sophisticated and have learnt a large amount of mathematics. One has to be open to the idea these systems will change the way mathematics is done, and how it is taught in universities.

At the ICERM workshop "Lean for the Curious Mathematician 2022", experts in the Lean theorem prover will explain how to do number theory, topology, geometry, analysis, and algebra in the Lean theorem prover. This will be accessible to mathematicians without a specific background in computer-proof systems. The material covered will range from undergraduate mathematics to modern research. Participants will be invited to begin formalizing mathematical objects from their own research.

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 organizers were very throughtful about the organization surrounding the group projects. Even with little Lean experience, we were able to get a great deal done in the week we were working together. It was an excellent experience.
- Over the past two years lots of interesting tool has been added to the proof assistant Lean, from cool widgets, Lean tools for teaching, AI aspects and so on. It was great to see many talks in this direction and talk to people behind all this work, and find possible collaboration avenues.
- ICERM add to my knowledge of computational methodologies by allowing me to interact with specialists in the Lean theorem prover and dependent type theory, as well as mathematicians from a very wide variety of disciplines. It even allowed me to meet people within my own mathematical field interested in interactive theorem proving.
- I am the "curious mathematician" this workshop was designed for. I knew little about Lean when I arrived, and I left having made a contribution to mathlib. I'm not sure how I could ask for more.

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

• It was amazing to hear from the people who are leading the effort to formalize large portions of mathematics in LEAN. I found it particularly remarkable to see how the mathematics library brought people together in designing coherent and robust foundations across different areas of mathematics. It was also flat-out stunning to see the polyrith tactic in action in Heather Macbeth's talk, where it called a computer algebra system (Sage) to solve a polynomial equation, and then knowing the answer, provided a formal verification. I felt like I could see the ground shifting to where a computer could play a serious role in proving results in mathematics, starting out by formally verifying computational tricky but theoretically not challenging parts of a proof.

- The highlight of this workshop was definitely the opportunity for collaboration and face-to-face social interaction. I have interacted with many of the people at this conference virtually for some time, but until now I have not had the opportunity to interact in-person. The week-long continual interaction was helpful for developing friendships and partnerships that will continue for years.
- The entire workshop was fantastic. I never thought I would have a chance to contribute to Mathlib by the end of the workshop. The outcome was far beyond my expectations.
- Tremendous environment, it has been a very fruitful week both concerning connections, knowledge and future projects.
- I found it amazing to see all the participants on Monday morning. Almost nobody knew other participants because of their very diverse backgrounds. But during the reception on Monday night, everybody was mixing and it looked like everyone knew the others for ages. The amount of active participation by participants in projects and exercises was very stimulating and rewarding to me as organizer. Some of the participants have continued to work on these projects after the workshop was over.

Topical Workshop 3: Privacy and Ethics in Pandemic Data Collection and Processing January 17 - 20, 2023

Organizing Committee:

Mark Lurie, Brown University Anna Lysyanskaya, Brown University Julia Netter, Brown University Sohini Ramachandran, Brown University Betsy Stubblefield Loucks, Brown University Kimani Toussaint, Brown University Thomas Trikalinos, Brown University

Workshop Description:

The collection and analysis of large-scale population level and individual mobility and social mixing data raises fundamental ethical questions related to privacy, individual autonomy, consent, and the distribution of power in society. Balancing those concerns with the desires of public health researchers and policy makers to learn what they need from the data is a central challenge. Ethics is a fundamentally discursive discipline and useful guidance on any of the challenges mentioned above can only result from actively engaging with a variety of perspectives and openly discussing their implications for the design and implementation of the big data-driven methods and technologies used in public health research. At the same time, ethicists must gain substantive insight into the technical details of these means if they are to identify and discuss specific concerns, and provide targeted recommendations.

In this multidisciplinary workshop, we will brainstorm new ethical challenges surrounding the collection of health-related data and also explore some concrete methods that can, for example, minimize privacy loss and mitigate avenues for social control in this area (e.g., multi-party computation, differential privacy). This program included additional funding for participants

from an NSF grant CBET-2154941 "PIPP Phase I: Mobility Analysis for Pandemic Prevention Strategies (MAPPS)", which is jointly held by most of the program organizers.

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.":

- ICERM conveyed collaborations across public health, engineering and mathematics
- Very helpful presentations and followup discussions.

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

- The breakouts were the BEST! Using new ideas and hearing them described in different ways by different participants made the ideas come alive for me. As well, what a great group of participants -- academics AND students alike. Seemed like just the right mix of disciplines.
- Loved meeting and working with people across disciplines to sharpen our research questions and priorities.

Collaborate@ICERM (C@I)

ICERM hosted 22 Collaborate@ICERM programs from May 2022 to April 2023.

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.

During this reporting cycle the following eligibility guidelines for Collaborate@ICERM (C@I) were developed:

The majority of group participants must be from U.S. institutions. C@I groups can include self-funded participants. The entire team should be present for the week at ICERM. An individual invited to more than one accepted C@I proposal within a given review cycle will only receive funding for one of the visits. Individuals should not participate in a C@I program more than twice within three years.

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.

3. Evaluation

We recently revised our evaluation process, which will apply to all groups meeting since the pandemic. Now ICERM surveys group members one year after their meeting, asking about publications, research products, grant proposals, and other outcomes resonating with ICERM's computational missions.

Collaborate@ICERM Participants and Projects

C@I 1: Higher Fano Manifolds (May 9 - 13, 2022)

- Carolina Araujo, IMPA
- Ana-Maria Castravet, University of Versailles, France
- Kelly Jabbusch, University of Michigan Dearborn
- Svetlana Makarova, UPenn
- Enrica Mazzon, Max Planck Institute for Mathematics
- Nivedita Viswanathan, The University of Edinburgh

C@I 2: The Energy Strip for Codes in Polynomial Metric Spaces (May 9 - 13, 2022)

- Peter Boyvalenkov, Institute of Mathematics and Informatics, Bulgarian Academy of Sciences
- Peter Dragnev, Purdue University Fort Wayne
- Doug Hardin, Vanderbilt University
- Edward Saff, Vanderbilt University
- Maya Stoyanova, Sofia University

C@I 3: Stochastic Theory for Data-Driven Paleoecosystem Models (May 9 - 13, 2022)

• Wenping Cui, UCSB

- Corinne Myers, University of New Mexico
- Sergei Petrovskii, University of Leicester
- Matthew Pound, Northumbria University
- Ivan Sudakow, University of Dayton

C@I 4: Explicit Galois Representations of Genus 2 Curves (May 16 - 20, 2022)

- Barinder Banwait, None
- Armand Brumer, Fordham University
- Hyun Jong Kim, University of Wisconsin-Madison
- Jacob Mayle, University of Illinois at Chicago
- Padmavathi Srinivasan, University of Georgia
- Isabel Vogt, Brown University

C@I 5: Moduli of I-Surfaces Via Wall Crossing (May 16 - 20, 2022)

- Kenneth Ascher, UC Irvine
- Kristin DeVleming, University of California, San Diego
- Yuchen Liu, Northwestern University
- Julie Rana, Lawrence University
- Fei Si, Beijing International Center for Mathematical Research

C@I 6: Improvements to Algorithms Around S-Unit Equations (May 23 - 27, 2022)

- Alejandra Alvarado, Eastern Illinois University
- Angelos Koutsianas, The University of British COlumbia
- Beth Malmskog, Colorado College
- Christopher Rasmussen, Wesleyan University
- Christelle Vincent, University of Vermont
- Mckenzie West, University of Wisconsin-Eau Claire

C@I 7: Algebraic Combinatorics of Weighted Oriented Graphs (June 6 - 10, 2022)

- Jennifer Biermann, Hobart and William Smith Colleges
- Selvi Kara, University of Utah
- Kuei-Nuan Lin, Penn State University, Greater Allegheny
- Augustine O'Keefe, Connecticut College

C@I 8: Practical Computation with Infinite Linear Groups (June 6 - 10, 2022)

- Alla Detinko, University of Huddersfield
- Dane Flannery, National University of Ireland
- Alexander Hulpke, Colorado State University
- Michael Kapovich, UC Davis
- Alex Kontorovich, Rutgers University

C@I 9: Arithmetical Structures on Graphs (June 6 - 10, 2022)

- Kassie Archer, University of Texas at Tyler
- Alexander Diaz-Lopez, Villanova University
- Darren Glass, Gettysburg College

• Joel Louwsma, Niagara University

C@I 10: Impartial Achievement and Avoidance Games for Generating Finite Groups (July 11 - 15, 2022)

- Bret Benesh, College of St. Benedict and St. John's University
- Dana Ernst, Northern Arizona University
- Marie Meyer, Lewis University
- Sarah Salmon, University of Colorado Boulder
- Nandor Sieben, Northern Arizona University

C@I 11: PSL(2; F) Representations of Homology Spheres (July 11 - 15, 2022)

- Neil Hoffman, Oklahoma State University
- Kathleen Petersen, University of Minnesota Duluth
- Eric Samperton, University of Illinois at Urbana-Champaign

C@I 12: Configuration spaces of graphs and moduli spaces of tropical curves (July 11 - 15, 2022)

- Christin Bibby, Louisiana State University
- Melody Chan, Brown University
- Nir Gadish, University of Chicago
- Claudia Yun, Brown University

C@I 13: Topological Applications of Khovanov Homology and Related Link Homologies (July 18 - 22, 2022)

- Carmen Caprau, California State University, Fresno
- Christine Ruey Shan Lee, University of South Alabama
- Radmila Sazdanovic, NC State University
- Melissa Zhang, University of Georgia

C@I 14: Experimental Validation of Observed Principles of Optimal Deep Networks (July 18 - 22, 2022)

- Kathryn Leonard, Occidental College
- J. Jenny Li, Kean University
- F. Patricia Medina, Yeshiva University
- Linda Ness, Rutgers University

C@I 15: Optimal Pots for Tile-Based Self-Assembly of DNA Complexes (August 8 - 12, 2022)

- Leyda Almodóvar Velázquez, Stonehill College
- Amanda Harsy, Lewis University
- Cory Johnson, California State University, San Bernardino
- Jessica Sorrells, Converse University

C@I 16: Modeling Dynamic Behavior in Evolving Networks (August 15 - 19, 2022)

• Carlotta Domeniconi, George Mason University

- Emily Evans, Brigham Young University
- Weihong Guo, Case Western Reserve University
- Emilie Purvine, Pacific Northwest National Laboratory
- Sibel Tari, Middle East Technical University

C@I 17: Quantum Error Correction (August 15 - 19, 2022)

- Sarah Anderson, University of St. Thomas •
- Eduardo Camps, Cleveland State University •
- Hiram López, Cleveland State University
- Gretchen Matthews, Virginia Tech
- Diego Ruano, University of Valladolid
- Ivan Soprunov, Cleveland State University

C@I 18: Point Configurations on Projective Varieties (January 9 - 13, 2023)

- Alessio Caminata, Università di Genova
- Noah Giansiracusa, Swarthmore College
- Han-Bom Moon, Fordham University
- Luca Schaffler, Roma Tre University

C@I 19: Dynamical algebraic combinatorics of permutations, interval closed sets, and knots (January 9 - 13, 2023)

- Jennifer Elder, Rockhurst University
- Nadia Lafreniere, Dartmouth College
- Erin McNicholas, Willamette University
- Jessica Striker, North Dakota State University
- Amanda Welch, Eastern Illinois University

C@I 20: Special Subvarieties of Hypersurfaces (January 9 - 13, 2023)

- Dori Bejleri, Harvard University
- Nathan Chen, Columbia University
- Kristin DeVleming, University of California, San Diego
- David Stapleton, University of Michigan

C@I 21: Bridging Modeling Modalities and Experimental Data with Equation Learning (January 23 - 27, 2023)

- Daniel Bergman, University of Michigan
- Trachette Jackson, University of Michigan
- Harsh Jain, University of Minnesota Duluth
- Kerri-Ann Norton, Bard College

C@I 22: The stability of pattern-forming fronts in the FitzHugh-Nagumo system (January 23 - 27, 2023)

- Montie Avery, Boston University
- Paul Carter, University of California, Irvine
- Björn de Rijk, Karlsruhe Institute of Technology

• Arnd Scheel, University of Minnesota

Extended Programs

ICERM received a proposal from a group with a new program format. They proposed hosting two extended length programs (from 4-6 weeks) over two summers and have associated week-long workshops during the program. Their goal is to establish a community around the theme, begin work in person during the first summer, carry on during the intervening academic year, and reconvene in the second summer in person again.

2022 Part: Data Science and Social Justice: Networks, Policy, and Education

June 13 - July 8, 2022

Organizing Committee:

Carrie Diaz Eaton, Bates College Joseph Hibdon, Northeastern Illinois University Drew Lewis, University of South Alabama Jessica Libertini, Joint Special Operations University Michelle Manes, National Science Foundation Omayra Ortega, Sonoma State University Victor Piercey, Ferris State University Bjorn Sandstede, Brown University Talitha Washington, Clark Atlanta University Tian An Wong, University of Michigan-Dearborn Heather Zinn Brooks, Harvey Mudd College (Claremont, CA, US)

Program Description:

The Social Justice and Data Science Summer Research Program at ICERM aims to increase interest, research training, and capacity for data science for social justice, and to develop both quantitative and qualitative approaches to those professional practices that call for community engagement, critical inquiry, and interdisciplinary cooperation. In order to advance the mathematics community's understanding of the complexity of computational social justice work, the program will have four emphasis areas (1) networks, (2) policy, (3) education and (4) community-driven research. While the program itself is broadly computational and applied mathematics, researchers with expertise and interests in network science and analysis, open science and data, and computer science are particularly encouraged to apply. As a new field emerges at the face of computational and applied mathematics and social justice, this requires new methods for working across community lines. The organizers are committed to working with humility and in solidarity with the local community. The program will include a long-term project with the local community and invest in the education of the next generation of researchers by driving the development and direction of new computational methods for quantitative social justice research. As such, organizers will also consider applications from researchers with specialties in digital humanities, computational social science, and data science education. In order to address the novel and interdisciplinary problems arising out of community needs, participants will work together to develop new or refine existing computational methods whose applications may be broader than the original problem.

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.":

- As a tech practitioner, much of what I do is based on advanced mathematics, however, I rarely had a chance to understand the fundamentals. It was incredibly valuable to be exposed to this at work
- My main work is in algebraic and geometric combinatorics. Participating in this program has presented me with new research directions and a new set of collaborators outside my main area of research.
- I learned about several "rapid-use" tailored networks science tools, such as Research Rabbit for exploring citation networks. I also had the opportunity to learn R. The combination of ability to create self-made tools (beyond my prior experience with Matlab, which is great but cannot, to my knowledge, do web scraping) with ready-to-use tools has made it easier for me to make progress on research questions I already had as well as open the door to new research questions.

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

- really enjoyed the mentoring part of the program. i think that was a great way to infuse additional connection between participants.
- Learning what Social Justice work looks like in mathematics.
- Everything. Working with people, but also their enthusiasm and team work. Loved the food hack project and the community based project work.

Workshop 1: Interdisciplinary Network Analysis Methods for Analyzing Social Systems

June 27 - July 1, 2022

Organizing Committee:

Nancy Rodriguez, University of Colorado at Boulder Heather Zinn Brooks, Harvey Mudd College (Claremont, CA, US)

Workshop Description:

The goal of this workshop is to introduce participants to interdisciplinary collaborations and conversations in network science that are advancing social justice research through the study of social structures. This workshop will bring together social scientists, digital humanists, computational scientists, and mathematicians with experience in network theory and network analysis in social systems. This workshop will also showcase how mixed methods research (which combines qualitative analysis and quantitative analysis) with multidisciplinary perspectives leads to deeper insights and more ethical and responsible approaches. Workshop organizers will lead tutorials in the mathematics of network theory, finding and working with network data, and qualitative methods for networks in the social sciences. We will emphasize

and showcase the use of a critical lens throughout the process, from model building to data collection and analysis, connecting us to a broader dialogue about algorithmic justice and the potential benefits and pitfalls of mathematical models. Participants will also have the option to engage in virtual interdisciplinary working groups continuing after the workshop, focused on problems in application areas including community organizing, education, social media and information dissemination, and healthcare.

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.":

- ICERM has given me the ability to not only work with network analysis with a social justice lens. I also obtained the ability to gain collaborations in this area to hopefully do more research using network analysis.
- I think that this workshop was good for starting a number of important conversations in Network Sciences and between mathematicians and other researchers.
- The group project I participated in at ICERM cultivated a starting point for future collaborations.

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

- This workshop allowed me to see the possibility of what a sociological mathematician can do with applications to social justice issues and gives me hope for the future work that will come from this experience. I look forward to my program and believe that I will thrive in mathematics as long as I do not forget the impact that my work can have on various communities. I have never witnessed work being done like this in the math community and am incredibly grateful to have been considered for such an incredible opportunity.
- The structure of the workshop, which consists of a mix of presentations and group work, helped me learning new skills from others and develop collaboration and connections with team members.
- I really enjoyed collaborating on the projects with the team. I thought all of the projects were thoughtful and interesting, and it was great to see the progress that folks made during the week. The environment felt really friendly, welcoming, and fun. The talks and tutorials were interesting and informative.

The list of participants for ICERM's 2022-2023 Extended Program can be found in Appendix D.

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 7-years (2017-2024), 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.

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: Topological and Dynamical Analysis of Brain Connectomes May 14 - 15, 2022

Organizing Committee:

Dmitri Chklovskii, Flatiron Institute & NYU Neuroscience Institute David Lipshutz, Flatiron Institute

Workshop Description:

With the substantial recent progress in connectomics, the study of comprehensive maps of nervous systems, much more is known about the connectivity structure of brains. This has led to a multitude of new questions about the relationship between connectivity patterns, neural dynamics and brain function, many of which lead to new mathematical problems in graph theory and dynamics on graphs. The goal of this workshop is to bring together a broad range of researchers from neuroscience, physics, mathematics, and computer science to discuss new challenges in this emergent field and promote new collaborations.

Hot Topics Workshop 2: Algebraic Geometry in Spectral Theory

February 24 - 26, 2023

Organizing Committee:

Stephen Shipman, Louisiana State University Frank Sottile, Texas A&M University

Workshop Description:

Discrete periodic Schrodinger operators describe the behavior of individual electrons in "ideal" crystals in the tight-binding model of solid state physics. Spectra of such operators have the usual band-gap structure, and the corresponding dispersion relations are algebraic varieties. In the 1990's Gieseker, Knorrer, and Trubowitz used toroidal compactifications to solve questions such as irreducibility of Bloch and Fermi varieties and the density of states, for a class of mono-atomic models. Their work showed that while spectral theory is focused on the real part of the Bloch variety, the study of complex singularities and compactifications is crucial for describing formation of bands and gaps.

After a gap of 30 years, spectral theory is again interacting with algebraic geometry. Recently, W. Liu gave an algebraic method to obtain more general proofs of irreducibility for Fermi surfaces, Kravaris used free resolutions to study density of states, and Kuchment and coauthors used toric varieties and numerical nonlinear algebra to study spectral edges. These and other developments have led to the realization that many open questions in spectral theory may be studied using modern tools in algebraic geometry. These include the relation of reducibility/irreducibility with physical symmetries of the crystals, the structure of spectral band edges, and Dirac cones. These methods can also be applied to quantum graphs, such as graphene-type structures, and to obtain existence and non-existence theorems for embedded eigenvalues. The goal of this workshop is to bring together experts from spectral theory, mathematical physics, and algebraic geometry to understand, apply, and advance these new methods and interactions.

A significant aspect of these reemerging interactions involves computation. A key recent development in algebraic geometry is computation, both symbolic and numerical. Computation and experimentation using tools from algebraic geometry have already been important in two recent papers by Sottile on this subject, and we expect it to become a useful tool for studying periodic operators. Speakers in this workshop are firmly rooted in the uses of computation and experimentation in applications of Algebraic Geometry, and many are familiar with exploiting the atmosphere and facilities of the ICERM to initiate collaboration.

Program Promotions

ICERM programs and events are typically marketed through a variety of outlets: its website, dedicated Facebook page, Twitter, and Instagram accounts, targeted blast emails, placement of advertisements in mathematical journals and newsletters, ICERM directorate participation in conferences and exhibits, upcoming program fliers and announcements made available to ICERM participants, and various on-line math organization calendars (researchseminars.org,, AMS, AWM, European Mathematical Society, National Math Institutes, and Conference Service Mandl). ICERM has discontinued the use of posters for large mailings as alternative advertising methods are effective, inexpensive and environmentally friendly.

ICERM's email database is made up of former and upcoming participants, local partners and community leaders, 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 19,000 contact emails.

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

ICERM's various communications, funder acknowledgements, and presence on Brown's fundraising page have helped ICERM maintain contact with board members, corporate and academic sponsors, and the general population. Brown continues to be committed to supporting ICERM's provost-approved fundraising goals, and Brown's Advancement department is committed to helping ICERM develop our fundraising strategy. However, Brown's Advancement department has seen some turnover and as a result efforts to help ICERM build relationships with corporations and foundations have not progressed as much as desired. There was little-to-no fundraising activity during this reporting cycle. Additionally due to ICERM's own staffing changes, the quarterly newsletter was suspended this year.

ICERM's communications strategy emphasizes maintaining regular contact with recent, current, and upcoming program participants and amplifying scientific results from workshops and collaborations initiated at ICERM. To meet these objectives, ICERM has reinstated a semesterly (Spring, Summer, and Fall) newsletter highlighting research fellows, program outcomes, and upcoming opportunities to visit ICERM. Participants with significant scientific outcomes are invited to work with the Director and Communications Specialist to share their results on mathinstitutes.org/highlights, or in the ICERM newsletter. In addition, frequent social media posts sharing workshop photos, high-interest events (e.g. GirlsGetMath and public lectures), ICERM-Brown connections, and alumni achievements help ICERM remain relevant in the mathematical community and attract prospective participants.

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.

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 and co-PIs, are invited to sit in.

Name	Institution
Leon Bottou	Facebook
Ron Buckmire	Occidental College
Anna Gilbert	Yale University
Leslie Greengard	Flatiron Institute & NYU Courant Institute of Mathematical Sciences
Julia Kempe	New York University
Rachel Kuske (chair)	Georgia Tech
Mark Lewis	Cornell University
Jonathan Mattingly	Duke University
Karen Smith	University of Michigan
Carol Woodward	Lawrence Livermore National Laboratory

Board of Trustee Members:

The following people rotated off the BOT at the end of June 2022: Charles Epstein and Bruce Hendrickson.

Note: The minutes from the May 26, 2022 annual Board of Trustees meeting can be found in Appendix E.

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 act as ex officio members of this committee.

Scientifie Havisory Dour a triefinderst		
Name	Institution	
Jennifer Balakrishnan	Boston University	
Jacob Bedroissian	University of Maryland	
Fioralba Cakoni	Rutgers University	
Ivan Corwin	Columbia University	
Eli Grigsby	Boston College	
Michael Holst	University of California, San Diego	
Yael Tauman Kalai	Microsoft Research	
Daniel Krashen	University of Pennsylvania	
Nathan Kutz	University of Washington	
Sven Leyffer (Chair)	Argonne National Laboratory	
Rosa Orellana	Dartmouth College	
Dana Randall	Georgia Institute of Technology	
Eric Vanden-Eijnden	New York University	
Rachel Ward	University of Texas	

Scientific Advisory Board Members:

The following people rotated off the SAB at the end of June 2022: Anne Gelb, William Goldman, Mauro Maggioni, and Jon Wilkening.

Upcoming Programs

ICERM already has a number of programs scheduled to take place in the coming years. The below listings have already been approved by the Scientific Advisory Board and are in the process of being developed.

Semester Programs (each with 3-4 associated workshops)

Fall 2023

Math+Neuroscience: Strengthening the interplay between theory and mathematics C. Curto, B. Doiron, R. Ghrist, K. Hess, Z. Kilpatrick, M. Marcolli, K. Mischaikow, K. Morrison, T. Sharpee, E. Schneidman

Spring 2024

Numerical PDEs: Analysis, Algorithms, and Data Challenges

M. D'Elia, B. Froese Hamfeldt, J. Guzman, M. Neilan, M. Olshanskii, S. Pollock, A.J. Salgado, V. Simoncini

Fall 2024

Theory, Methods, and Applications of Quantitative Phylogenomics

E. Allman, C. Ané, E. Gross, B. Holland, L. Kubatko, S. Linz, S. Mirarab, J. Rhodes, S. Roch, L. van Iersel

Spring 2025

Geometry of Materials, Packings and Rigid Frameworks

A. Bobenko, J. Bowers, P. Bowers, R. Connelly, S. Gortler, M. Holmes-Cerfon, S. Matsumoto, A. Nixon, M. Sitharam

Topical Workshops

<u>2023</u>

1. Optimal Transport in Data Science

S. Aeron, M. Katsoulakis, J. Murphy, L. Rey-Bellet, B. Sandstede

- 2. Dynamics, Rigidity AND Arithmetic in Hyperbolic Geometry
 - D. Fisher, D. Kelmer, H. Oh, A. Reid
- 3. Tangled in Knot Theory
 - S. Blatt, E. Panagiotou, P. Reiter, R. Sazdanovic, A. Schikorra
- 4. Mathematical and Scientific Machine Learning
 - M. D'Elia, G. Karniadakis, S. Mishra, T. Sapsis, J. Xu, Z. Zhang

5. Mathematical and Computational Biology

W. Hao, P. Kevrekidis, M. Kuijjer, O. Prosper, L. Shahriyari, N. Whitaker

6. Modern Applied and Computational Analysis

A. Gilbert, R. Lederman, G. Lerman, P.G. Martinsson, A. Nahmod, K. Serkh, C. Thiele, S. Wu

7. Acceleration and Extrapolation Methods H. De Sterck, D.Gardner, A. Miedlar, S. Pollock

8. Computational Tools for Single-Cell Omics

A. Blumberg, I. Corwin, I. Pe'er

<u>2024</u>

1. Connecting Higher-Order Statistics and Symmetric Tensors

J. Kileel, T. Kolda, J. Morais Carreira Pereira

- 2. Interacting Particle Systems: Analysis, Control, Learning and Computation J. Carrillo, K. Craig, M. Fornaiser, F. Lu, M. Maggioni, K. Ramanan
- 3. Recent Progress on Optimal Point Distributions and Related Fields D. Bilyk, X. Chen, E. King, D. Mixon, K. Okoudjou
- 4. Queer in Computational and Applied Mathematics (QCAM)R. Barker-Clarke, R. Choksi, A, Hoover, H. Monterde, M. Robert, C. Sawyer, B. Thomases
- 5. Solving the Boltzmann Equation for Neutrino Transport in Relativistic Astrophysics

I. Cordero-Carrion, F. Foucart, S. Liebling, C. Palenzuela, L. Pareschi, D. Radice

- 6. Empowering a Diverse Mathematical Community V. Bokil, S. Gottlieb, F. Li, S. Weekes
- 7. Simulating Extreme Spacetimes with SpEC and SpECTRE N. Deppe, S. Field, L. Kider, G, Lovelace, L. Stein, M. Scheel, S. Teuklsky, N. Vu

Collaborate@ICERM

<u>2023</u>

1. Learning Temporal Representations of Dynamic Networks for Anomaly Detection and Community Discovery

M. Ferhat Arslan, C. Comeniconi, E. Evans, W. Guo, E. Purvine, S. Tari

2. Web Bases, Promotion, and Plabic Graphs

C. Gaetz, O. Pachenik, S. Pfannerer-Mittas, J. Striker, J. Swanson

3. Computing Volumes of Flow Polytopes

C. Benedetti V., R. Santiago Gonzalez De Leon, C. Hanusa, P. Harris, A. Morales, M. Yip

4. Milnor forms of algebraic singularities

C-Y Chan, T. Hagedorn, J. Louwsman, M. Mijaya

5. Order Preserving Braids

J. Johnson, N. Scherich, H. Turner

- 6. Vacillating Tableaux for Integer Sequences
 - Y. A. Pun, Z. Berikkyzy, P. Harris, C. Yan, C. Zhao
- Fixed-Group Conjugacy Classes of Unipotent Elements in Symmetric Spaces of SpecialLinear Groups over a Finite Field of Characteristic 2
 C. Buell, A. Helminck, V. Klima, J. Schaefer, E. Ziliak

Summer@ICERM

2023

1. Mathematical Modeling of DNA Self-Assembly

L. Almodovar, A. Harsy, C. Johnson, J Sorrells

Reunion Events - these programs are designed to bring together as many of the attendees originally scheduled to attend programs which were switched to virtual due to the pandemic.

2023

1. Spring 2021 Reunion Event

A. Buch, M. Chan, J. Huh, T. Lam, L. Mihalcea, S. Payne, L. Williams

Extended Program - this program takes place in summer 2022 and summer 2023 with work being carried out in between the sessions virtually.

<u>2023</u>

Data Science and Social Justice: Networks, Policy, and Education

C. Diaz Eaton, J. Hibdon, D. Lewis, J. Libertini, M. Manes, O. Ortega, V. Piercey, B. Sandstede, T. Washington, T. A. Wong, H. Zinn Brooks

Note: The minutes from the May 30, 2023 mid-year SAB conference call and the November 14-15, 2022 SAB annual meeting can be found in Appendix F.

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.

Name	Institution
Cathy Boutin	West Warwick School Department (Math)
John Ewing	Math for America
Thomas Garrity (Chair)	Williams College

Education Advisory Board Members:

Edray Goins	Pomona College
Ryan Hynd	University of Pennsylvania
Katharine A. Ott	Bates College
Javier Rojo	Oregon State University
Julianna Tymoczko	Smith College
Ulrica Wilson	Morehouse College
Darryl Yong	Harvey Mudd College

The following people rotated off the EAB: Tarik Aougab, Rachel Levy, and Jessica Sidman.

Note: The minutes from the September 2022 annual Education Advisory Board meeting can be found in Appendix G.

Mathematics Institute Directors Meeting (MIDs)

The April 2022 MIDs meeting minutes can be found in Appendix H.

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 Mathematics Meeting. 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 from the Directors. A member of the committee serves as the diversity lead, with access to EEO/AA data needed to support our goal of recruiting from a wide range of backgrounds.

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 ranked lists, and may suggest changes to ensure diversity and field balance. The Director approves all offers, and Brown University's Dean of the Faculty oversees postdoctoral offers and appointment terms.

2022-2023 ICERM Postdoctoral Cohort

ICERM Postdoctoral Fellows (4 months w/benefits; funds for research travel)

Name	Previous Institute	ICERM Semester Program
Alexandros Eskenazis	University of Cambridge	Fall 2022
Fushuai Jiang	UC Davis	Fall 2022
Naga Manasa Vempati	Georgia Institute of Technology	Fall 2022
Katarzyna Wyczesany	Tel Aviv University	Fall 2022
Sudan Xing	University of Alberta	Fall 2022
Sean Kafer	University of Waterloo	Spring 2023
Chiara Meroni	Max Planck Institute for Mathematics in	Spring 2023
	the Sciences	
Bento Natura	Georgia Institute of Technology	Spring 2023

ICERM Institute Postdoctoral Fellows (9 months w/benefits; funds for research travel)

Name	Previous Institute	ICERM Semester Program
Michael Roysdon	Tel Aviv University	2022-2023: focus on Fall 2022
Nimita Shinde	IIT Bombay	2022-2023: focus on Spring 2023
Shixuan Zhang	Georgia Institute of Technology	2022-2023: focus on Spring 2023

Based on available information, the ICERM stipend-supported postdocs for 2022-2023 breakdown as follows:

<u>Male</u>	<u>Female</u>
0	0
2	3
1	0
0	0
4	2
0	0
<u>0</u>	<u>0</u>
	<u>Male</u> 0 2 1 0 4 0 <u>0</u>

$$7 + 5 = 12$$
 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 2023?
Emre Esenturk	Fall 2011	Jesus College, University of Oxford
Jeffrey Haack	Fall 2011	Los Alamos National Laboratory
Andong He	Fall 2011- Spring 2012	Passed away in 2016
Ahmed Kaffel	Fall 2011	University of Wisconsin-Milwaukee
Daniela Tonon	Fall 2011	Università degli Studi di Padova
Dongming Wei	Fall 2011	RBC Capital Markets
Cecile Armana	Spring 2012	University of Franche-Comté
Anupam Bhatnagar	Spring 2012	Meta
Alon Levy	Fall 2011 – Spring 2012	NYU The Marron Institute
Bianca Viray	Spring 2012	University of Washington
Xiaoguang Wang	Spring 2012	Virginia Tech
Daniel Cargill	Fall 2012	Lockheed Martin
Arnab Ganguly	Fall 2012	University of Wisconsin - Whitewater
Peng Hu	Fall 2012	Oxford University
Hao Ni	Fall 2012	University College London
Aaron Smith	Fall 2012 - Spring 2013	University of Ottawa
Julio Andrade	Fall 2012 - Spring 2013	University 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	POSTECH
Rodolfo Rios-Zertuche	Fall 2013	Laboratoired'Analyseetd'Architecturedes

		Syst`emes–CNRS
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	Max Planck Institute for Informatics
Amanda Redlich	Spring 2014	UMASS Lowell
Charalampos Tsourakakis	Spring 2014	Boston University
Grigory Yaroslavtsev	Fall 2013 - Spring 2014	George Mason University
Ali Ahmed	Fall 2014	Information Technology University (Lahore); Director of CACTuS; CEO of Qult Technologies
Ulas Ayaz	Fall 2014 – Spring 2015	Google
Jacqueline Davis	Fall 2014	
Pawel Siedlecki	Fall 2014	University of Warsaw
Li Wang	Fall 2014	University of Illinois
Tyler Helmuth	Spring 2015	Durham University
Marcin Lis	Spring 2015	Vienna Institute of Technology
Emily Russell	Fall 2014 – Spring 2015	Google
Xuan Wang	Spring 2015	Data Scientist at Databricks
Samuel Watson	Spring 2015	RelationalAI
Olga Balkanova	Fall 2015	Steklov Mathematical Institute of Russian Academy of Sciences
Sandro Bettin	Fall 2015	Università degli studi di Genova
Edgar Costa	Fall 2015	MIT
Anna Medvedovsky	Fall 2015 – Spring 2016	Boston University
James Weigandt	Fall 2015 – Spring 2016	Freelance
Abel Farkas	Spring 2016	Alfréd Rényi Institute of Mathematics
Marta Canadell Cano	Fall 2015 – Spring 2016	Wallapop
Nishant Chandgotia	Spring 2016	Tata Institute of Fundamental Research
Zhiqiang Li	Spring 2016	Peking University
Polina Vytnova	Spring 2016	Univeristy of Surrey
Hannah Alpert	Fall 2016 – Spring 2017	Auburn University

Chaim Even-Zohar	Fall 2016	Technion - Israel Institute of Technology
Isaac Mabillard	Fall 2016	Google
Greg Malen	Fall 2016	Union College
Jose Alejandro Casas	Fall 2016	Pontificia Universidad Católica de Chile
John Wiltshire-Gordon	Fall 2016	Zagaran Inc.
Sergey Dyachenko	Fall 2016 – Spring 2017	University of Illinois, Urbana-Champaign
Seok Hyun Hong	Spring 2017	Pohang University
Cecilia Mondaini	Spring 2017	Drexel University
Olga Trichtchenko	Spring 2017	Western University
Xuecheng Wang	Spring 2017	Tsinghua University
Xiaoqian Xu	Spring 2017	Duke University
Mario Bencomo	Fall 2017 – Spring 2018	California State University, Fresno
Wei Li	Fall 2017	DePaul University
Shixu Meng	Fall 2017	University of Michigan
Yimin Zhong	Fall 2017	Auburn University
David de Laat	Spring 2018	Delft University of Technology
Maria Dostert	Spring 2018	Munters
Philippe Moustrou	Spring 2018	Université Toulouse Jean Jaures
Yuguang Wang	Spring 2018	Shanghai Jiao Tong University
Wei-Hsuan Yu	Fall 2017 – Spring 2018	National Central University in Taiwan
Daniel Bernstein	Fall 2018	Tulane University
Papri Dey	Fall 2018	Georgia Institute of Technology
Mareike Dressler	Fall 2018	University of New South Wales
Kathlén Kohn	Fall 2018	KTH/Stockholm
Sara Lamboglia	Fall 2018	Goethe-Universität
Dane Wilburne	Fall 2018	The MITRE Corporation
Marilyn Vazquez	Fall 2018 – Spring 2019	Postdoc at MBI
Shubhendu Trivedi	Fall 2018 – Spring 2019	MIT
Guangyao Zhou	Spring 2019	DeepMind
Gabriel Dorfsman	Fall 2019	St. Lawrence University
Alba Málaga Sabogal	Fall 2019 – Spring 2020	Université de Lorraine

Michael Musty	Fall 2019	ERDC-CRREL
Martin Skrodzki	Fall 2019	TU Delft
Steve Trettel	Fall 2019	University of San Francisco
Gregory Darnell	Fall 2019 – Spring 2020	Apple
Davide Palitta	Spring 2020	Università di Bologna
Jemima Tabeart	Spring 2020	University of Oxford
Michael Schneier	Spring 2020	University of Pittsburgh
Min Wang	Spring 2020	University of Houston
Stefan Czimek	Fall 2020 – Spring 2022	University of Leipzig
Martin Licht	Fall 2020	EPFL
Jacob Lange	Fall 2020	Rochester Institute of Technology
Caroline Mallary	Fall 2020	UMass Dartmouth
Zachary Nasipak	Fall 2020	NASA Goddard Space Flight Center
Brendan Keith	Fall 2020	Brown University
Sunita Chepuri	Spring 2021	Lafayette College
Netanel Friedenberg	Spring 2021	Tulane University
Sean Griffin	Spring 2021	UC Davis
Daoji Huang	Fall 2020 – Spring 2021	University of Minnesota
Gleb Nenashev	Spring 2021	Brandeis University
Louise Gassot	Fall 2021 - Spring 2022	Mathematics Institute of Rennes (IRMAR)
Amirali Hannani	Fall 2021	KU Leuven
Kyle Liss	Fall 2021	Duke University
Anastassiya Semenova	Fall 2021 - Spring 2022	University of Washington
Annalaura Stingo	Fall 2021	UC Berkeley
Jiaqi Yang	Fall 2021 - Spring 2022	Clarkson University
Antonio Alfieri	Spring 2022	Université du Québec à Montréal, and McGill University
Lei Chen	Spring 2022	University of Maryland
Jonathan Johnson	Spring 2022	Oklahoma State
Sudipta Kolay	Fall 2021 - Spring 2022	Pursuing Industry Positions
Nancy Scherick	Fall 2021 - Spring 2022	Elon University

Hannah Turner	Spring 2022	Georgia Institute of Technology
Yvon Verberne	Spring 2022	University of Toronto
Steven Amelotte	ICERM Bridge Postdoc	University of Western Ontario
Justin (Yi-Chang) Chen	ICERM Bridge Postdoc	
Jayan Mukherjee	ICERM Bridge Postdoc	Oklahoma State
Rahul Singh	ICERM Bridge Postdoc	Tutor Intelligence
Alexandros Eskenazis	Fall 2022	University of Cambridge; Sorbonne University
Katarzyna (Kasia) Wyczesany	Fall 2022	Carnegie Mellon University
Fushuai Jiang	Fall 2022	University of Maryland
Sudan Xing	Fall 2022	Syracuse University
Naga Manasa Vempati	Fall 2022	Georgia Institute of Technology
Michael Roysdon	Fall 2022 – Spring 2023	Case Western University
Nimita Shinde	Fall 2022 – Spring 2023	Lehigh University
Shixuan Zhang	Fall 2022 – Spring 2023	Texas A&M University
Bento Natura	Spring 2023	Georgia Institute of Technology
Sean Kafer	Spring 2023	
Chiara Meroni	Spring 2023	ETH Zurich

Graduate Students

Support for Graduate Students

The research semester program budget typically includes partial support for a cohort of graduate students. Applicants include graduate students working with visitors to the program, as well as students who intend to attend without an advisor. Graduate students must arrange for a letter of recommendation from their advisor to be sent separately. The graduate student applications are prioritized by the semester program organizing committee (1 - Would make a contribution to this program; 2 - Desirable for this program but not high priority; 3 - High priority, important for the success of the program). The prioritized list is 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 a semester program starts, ICERM attempts to assign a mentor to all postdocs and graduate students. The institute provides all senior mentors with written guidelines that spell out their responsibilities and the responsibilities of mentees. Currently, the assigned ICERM Deputy

Director coordinates these efforts and works with the members of the Program Organizing Committee assigned to be responsible for mentorship.

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.

Postdoc	Mentor	Program/How Supported			
Alexandros Eskenazis	Alexander Koldobskiy	Fall 2022 Semester Postdoc (NSF Funds)			
Fushuai Jiang	Artem Zvavitch	Fall 2022 Semester Postdoc (NSF Funds)			
Naga Manasa Vempati	Ben Jaye	Fall 2022 Semester Postdoc (NSF Funds)			
Katarzyna Wyczesany	Artem Zvavitch and Elizabeth Werner	Fall 2022 Semester Postdoc (NSF Funds)			
Sudan Xing	Alexander Koldobskiy	Fall 2022 Semester Postdoc (NSF Funds)			
Michael Roysdon	Alexander Koldobskiy	Fall 2022 Institute Postdoc (NSF & Simons			
		Funds)			
Sean Kafer	Laura Sanita and Jesús	Spring 2023 Semester Postdoc (NSF Funds)			
	DeLoera				
Chiara Meroni	Jesús De Loera	Spring 2023 Semester Postdoc (NSF Funds)			
Bento Natura	Daniel Dadush	Spring 2023 Semester Postdoc (NSF Funds)			
Nimita Shinde	Fatma Kilinc-Karzan	Spring 2023 Institute Postdoc (NSF Funds)			
Shixuan Zhang	Greg Blekherman	Spring 2023 Institute Postdoc (NSF Funds)			

ICERM Postdoctoral Participant and Mentor list by Semester Program

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: <u>https://icerm.brown.edu/pds/</u>

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. Proposals are reviewed and prioritized by the Education Advisory Board, which usually offers substantive feedback to the proposers.

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. A member of the faculty organizing committee serves as the diversity lead, with access to EEO/AA data needed to support our goal of recruiting from a wide range of backgrounds.

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 2022: Summer@ICERM – Computational Combinatorics

June 13 - August 5, 2022

Organizing Committee:

Susanna Fishel, Arizona State University Pamela E. Harris, Williams College Gordon Rojas Kirby, Arizona State University

Program Description

The Summer@ICERM faculty advisers will present a variety of research projects on the combinatorics of parking functions. This overarching theme will allow participants to study and analyze parking functions by leveraging computational techniques and theory. Faculty will also guide the development of open-source computational tools for analyzing parking functions and their statistics, with time devoted to creating a database of parking functions and their generalizations.

Throughout the eight-week program, 18-22 students will work on their 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, and will acquire skills in free software development. Students will learn how to collaborate mathematically, working closely in their teams to write up their research into a paper.

2022 Proposed Research Project Topics

- 1. Invariant and Prime Parking Sequences
- 2. Statistics on parking functions and their generalizations
- 3. Connection to posets and graph theory, algebraic structures, and discrete geometry

2022 Summer@ICERM Cohort

The Summer@ICERM 2022 program had a cohort of 18 students. All of them were funded through the NSF.

Student Name	Institute	Funding Source
Cara Bennett	Georgia Institute of Technology	ICERM
Josephine Brooks	University of Toronto	ICERM
Lucas Chaves Meyles	University of California, Los Angeles	ICERM
Douglas Chen	Johns Hopkins University	ICERM
Richter Jordaan	MIT	ICERM
Zoe Markman	Swarthmore College	ICERM
Ava Mock	Wellesley College	ICERM
Eric Pabón-Cancel	University of Puerto Rico, Mayagüez Campus	ICERM
Eva Reutercrona	Pacific Lutheran University	ICERM
Sophie Rubenfeld	Hamilton College	ICERM
Gabriel Sargent	University of Notre Dame	ICERM

Ethan Spingarn	Amherst College	ICERM
Izah Tahir	Georgia Institute of Technology	ICERM
Bianca Teves	Haverford College	ICERM
Robin Truax	Stanford University	ICERM
Amanda Verga	Trinity College	ICERM
Susan Wang	Mount Holyoke College	ICERM
Juliet Whidden	Vassar College	ICERM

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 relationships I built with other students.
- Research presentations; they were a testament to everyone's hard work.
- The highlight of the program for me was the incredible networking opportunities that ICERM has.
- Doing lots of math via research and learning a lot in the process.
- Just being able to be there for 8 weeks focused on research and mentoring

Summer@ICERM 2022 Scientific Outcomes to Date

Final Student Presentations

- On Flattened Parking Functions
 - Zoe Markman, Swarthmore College
 - Izah Tahir, Georgia Institute of Technology
 - Amanda Verga, Trinity College
- Out of the Parking Lot and into the Forest: Parking Functions, Bond Lattices, and Unimodal Forests
 - Josephine Brooks, University of Toronto
 - Sophie Rubenfeld, Hamilton College
 - Bianca Teves, Haverford College
 - Parking Functions with Fixed Ascent and Descent Sets
 - Eva Reutercrona, Pacific Lutheran University
 - Susan Wang, Mount Holyoke College
 - Juliet Whiden, Vassar College
- Repetitions of Pak-Stanley Labels in the G-Shi Arrangement: Playing Games on Paths, Trees, and More
 - Cara Bennett, Georgia Institute of Technology
 - Ava Mock, Wellesley College
 - Robin Truax, Stanford University
- Parking Functions with Fixed Displacement
 - Lucas Chaves Meyles, University of California, Los Angeles
 - Richter Jordaan, MIT
 - Ethan Springarn, Amherst College
- On Permutation Invariant Parking Sequences

- Douglas Chen, Johns Hopkins University
- Eric Pabón-Cancel, University of Puerto Rico, Mayagüez Campus
- Gabriel Sargent, University of Notre Dame

Posters Presented at JMM 2023

- Permutation Invariant Parking Functions with Cars of Arbitrary Lengths
- Subsets of Unit Interval Parking Functions Enumerated by Fubini Numbers
- Out of the Parking Lot and into the Forest: Parking Functions, Bond Lattices and Unimodal Forests
- On Flattened Parking Functions
- Repetitions of Pak-Stanley Labels in the G-Shi Arrangement: Playing Games on Paths, Trees, and More

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.

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.

To boost survey response rates during this reporting cycle, the SAB suggested the program organizers send a "heads up/please respond" email to their program's long-term participants prior to putting the follow-up surveys in the field. This request resulted in an increased response rate (from our average of 50% for the two-year-follow-up and 36% for the five-year-follow-up to 52% and 55%, respectively.

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.

With SRG's help, the institute developed a longitudinal comparison report using a program's exit survey, as well as its 2 and 5-year follow-up survey. In this way, ICERM can 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

The challenge is having high enough response rates for the collected data to draw meaningful conclusions.

The SAB is interested in seeing details about a program's long-term impact. It reviews outcomes of past programs in its annual meeting, to focus attention on the potential long-term outcomes of programs it reviews. The challenge in the coming year is to pare down the massive quantity of information we collect to something more concise. ICERM will endeavor to simplify and streamline our survey instruments, with a view toward what we need for formative evaluation (in our director-manager meetings) and summative evaluation (led by our boards).

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: Exit survey summaries for core programs run during this reporting cycle (May 6, 2022 through May 1, 2023) can be found in Appendix I.

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 5-year follow-up survey for each of its semester programs, scientific outcomes have begun to be collected much more systematically and consistently. In general, the response rate for all survey types has remained steady over the past four years, when ICERM first began tracking response rates.

During ICERM's 2021 Board of Trustees Meeting, the idea came up to present the publication information collected in these surveys somewhere to highlight accomplishments of ICERM programs and participants. Over the past year a project was carried out which resulted in publications being added to the program's website that the author(s) attended. Our semester programs now include listings as soon as ICERM is made aware of an attributable publication to the program and a database has been made to manage the information. So far over 600 publications have been added to the related program pages. In the coming year the goal is to have similar upgrades to the Summer@ICERM and Collaborate@ICERM pages.

Note: a list of publications initiated at ICERM since ICERM's years 2021-2022 report can be found in Appendix J.

Future Plans for Evaluations

Based on the feedback from ICERM's Scientific Advisory Board, ICERM has started to take steps to modify the current evaluation summary format. The goal is to provide quickly comprehensible data points and highlight standout responses from the open ended questions. This would effectively streamline the summary from the current format which can quickly grow to several pages. Further we hope that by having this done in-house will allow for more flexible responsiveness to the needs of the SAB and the participants taking the surveys. The 2 and 5 year follow up surveys were used as a test and the initial responses were good. With some additional staffing, plans are in development to expand upon this momentum to manage more aspects in-house and survey more of the groups.

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 \$92,500 in corporate sponsorship funds.

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 \$99,375 in academic sponsorship funds. Academic sponsors have included:

- Cornell University, Department of Mathematics
- Indiana University, Bloomington, Department of Mathematics
- Korea Advanced Institute of Science and Technology, Dept. 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. Director Brendan Hassett and Assistant Director Juliet Duyster manage 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.

Other Funding Support received in 2022-2023

Additional Grants		Amount
American Mathematical Society Epsilon Fund	\$	2,500.00
(for GirlsGetMath@ICERM)		
JetBlue Foundation	\$	50,000.00
(for expanding the GirlsGetMath program nationally)		
Math for America	<u>\$</u>	3,430.02
(for GirlsGetMath@ICERM)		

Sub-total	\$ 55,930.02
University Funding Support	
University Research Committee	\$ 75,000.00
Sub-total	\$ 75,000.00
Sponsor Support	
Academic Sponsors	\$ 0.00
Corporate Sponsors	\$ 0.00
Individual Sponsors	\$ 9,650.00
Sub-total	\$ 9,650.00
TOTAL	\$ 140,580.02

Diversity and Outreach

Ulrica Wilson, 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.

ICERM's Directors present demographic data each year to its Board of Trustees, indicating progress toward its diversity goals and soliciting advice on how to improve our efforts.

When invitations are issued to speakers or long-term program participants, Directors ask questions when 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. During this reporting cycle ICERM hosted the "Research Communities in Algebraic Combinatorics" workshop.

ICERM typically 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. None of these events were held, or ICERM chose not to participate, during this reporting cycle due to the pandemic.

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

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 supports the AWM mentor network
- GirlsGetMath@ICERM high school math camp (outside funding)
- ICERM has a committee to support Brown University's diversity and inclusion action plan
- ICERM sponsored two proposals in the NSF PRIMES program offering support for faculty at minority-serving institutions to attend our semester programs

Outreach Activities

Public Lectures

ICERM has gained a reputation for providing the Brown community and the general public with an excellent public lecture series. These lectures attract a broad audience, from high school students on up.

During this reporting cycle, three virtual public lectures were held:

- Mirror Mirror on the Wall: the story of reflection groups and fractal sphere-packings with Alex Kontorovich (November 2022)
- A Polyhedral Invitation to Mathematics with Jesús A. De Loera (April 2023)

GirlsGetMath@ICERM

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

Because GirlsGetMath incorporates so many interactive, hands-on experiences, and the participants benefit from meeting peers with shared interests, we determined that a virtual version of the program this summer would lose its impact.

We worked with the founding program organizers (Katharine Ott and Amanda Tucker) to come up with an alternate plan that provided meaningful and engaging content in keeping with the spirit of the program. A very abbreviated, asynchronous version of GirlsGetMath was made available to every applicant as well as the general public. Two-to-three videos of Katy and Amanda presenting a selection of modules related to the GirlsGetMath curriculum (as well as some downloadable activities) are still posted on ICERM's GirlsGetMath website.

GirlsGetMath was 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 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.

Thanks to funding from the JetBlue Foundation in 2018, ICERM developed a train-the-trainer opportunity for nine faculty who were interested in replicating a GirlsGetMath program at their home institutions. The observational training occurred during ICERM's summer 2019 GirlsGetMath program. The train-the-trainer participants were then given the opportunity to apply for start-up seed funds to run their own programs. The program was ultimately able to support five programs. The locations were Stonehill College in 2021, Colorado State University in 2022, Boston University in 2022, University of Michigan-Dearborn in 2022, and University of Central Oklahoma in 2022. The feedback at all locations was well received and most of the sites report planning to host programs in future years.

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.

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.

Alabama7Delaware5Iowa2Kansas2Kansas1Louisiana11Maine2Mississippi6Missouri9New Hampshire3New Mexico5North Dakota4	CoR State	fof ICERM Participants
Delaware5Iowa2Kansas2Kansas1Kentucky4Louisiana11Maine2Mississippi6Missouri9New Hampshire3New Mexico5North Dakota4	na	7
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New Mexico 5 North Dakota 4 Okłabama 1	ampshire	3
North Dakota 4	lexico	5
Oklahama 1	Dakota	4
	oma	1
Rhode Island 98	Island	98
South Carolina 6	Carolina	6
Tennessee 4	see	4
Utah 8		8
Vermont 4	nt	4
West Virginia 1	/irginia	1
Wyoming 1	ing	1

Accepted ICERM participants from EPSCoR States

Administration and Staff

The ICERM Directors who received funding from the NSF core grant during this reporting cycle were Carolyn Klivans, Benoit Pausader, Jill Pipher, Kavita Ramanan, Bjorn Sandstede. Brendan Hassett commits 100% time.

ICERM Staff

Events Team

Halle Bryant, Communications Specialist, hired January 2023: reports to the Assistant Director of Programs and Operations. Ensures that there is a robust communications strategy for the institute, and that all communications are executed in a professional manner in line with current best practices and trends. This position is responsible for managing social media platforms and marketing materials (print and digital, with a focus on a digital-first communications strategy). Collaborates with Brown University's department of Advancement to create opportunities for donor engagement and stewardship.

Teresa Fitzsenry, Program Specialist, hired October 2016: reports to the Assistant Director of Programs and Operations. 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 Assistant Director to maintain standard operating procedures and consistent experiences for all participants..

Steven Freund, Program Coordinator, hired July 2022: reports to the Assistant Director of Programs and Operations. 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, 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.

Finance Team

Carly Seaman, Financial Coordinator, hired March 2022: reports to the Manager of Finance and Administration. Serves as primary point of contact for ICERM staff, program organizers, visitors, postdocs, students, vendors, and sponsor agencies for all financial transactions and related issues; reconciles the day-to-day financial activity for expenses supported by sponsored projects and University appropriated budgets.

Nina Succi, Manager of Finance and Administration, hired February 2016: reports to the Assistant Director of Finance and Administration. Supports grant proposal submissions, general grant management, and reporting. Provides human resources guidance and support to the department. Engages with intercampus departments to resolve issues that arise within financial, human resources, and grant domains.

IT Team

Christopher Cate, Senior Systems Administrator, hired April 2022: reports to the Director of IT. Manages and Maintains software, systems, servers, and infrastructure necessary to support ICERM programs, and oversees technical support.

João Dos Santos, Senior Application Developer, hired March 2022: reports to the Senior Application Developer. 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.

Departed Staff Members

Andy Alter, IT Support Coordinator, hired April 2022 and departed in June 2023: reported to the Senior Systems Administrator. Provided A/V support for the institute's programs and events as well as technical support for program participants.

Bernadette McHugh, IT Customer Experience Manager, hired in September 2012 and departed in August 2022: reported to the Senior Systems Administrator. Updated and maintained website content, web-based applications, and social media used to support and promote ICERM and its activities. Provided A/V support for the institute's workshops and events. Assisted with technical support for program participants.

Shadira Presbot, Program Assistant, hired March 2022 and departed April 2023: reported to the Program Specialist. Was the first point of contact for ICERM visitors. Acted as receptionist/concierge. Assisted with updating and posting schedules, tracking invitations, visitor data entry, all event prep and set-up.

Tori Santonil, Senior Application Developer, hired October 2017 and departed January 2023: reported to the Director of IT. Performed project management. Led 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.

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 70 research papers and has authored or co-edited eight 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 2010. As the Director of Information Technology, 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.

Juliet Duyster, Assistant Director of Finance and Administration, was hired in August 2011. She has 15+ years experience in higher education. She is responsible for directing the long-range and day-to-day financial and administrative activities that support ICERM's 18-20 mathematical conferences and 1,000+ international scientific researchers annually. She supervises the financial staff, works closely with the Directorate, is involved in management planning sessions for the Institute, and serves as the primary financial advisor and administrative risk manager. Juliet received both her BS and her MBA from Nova Southeastern University.

Jeffrey Hoffstein is a Department Chair and Professor of Mathematics at Brown University as well as an ICERM Consulting Associate 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 the 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 10 patents for his cryptographic inventions. He was a co-founder of Ntru Cryptosystems, Inc., which was recently acquired by Qualcomm.

Misha Kilmer is a William Walker Professor of Mathematics at Tufts University and an ICERM Deputy Director. She has a secondary appointment in the Department of Computer Science at Tufts University and a co-PI of Tufts TRIPODS Institute. She has been a Tufts Data Intensive Studies Center (DISC) Faculty Fellow since January 2021. In 2019, Prof. Kilmer was named a Fellow of the Society for Industrial and Applied Mathematics (SIAM) "for her fundamental contributions to numerical linear algebra and scientific computing, including ill-posed problems, tensor decompositions, and iterative methods." She served as Chair of the Tufts Department of Mathematics from 2013 to 2019. She is a 2001 recipient of the Tufts Undergraduate Initiative in Teaching Award and was promoted directly from Assistant to Full Professor in 2005.

Caroline Klivans is an Associate Professor of Applied Mathematics at Brown University and an ICERM Deputy Director. As Deputy Director, her responsibilities include: overseeing semester programs and other institute activities such as summer programming and special events, assisting in solicitation and development of programs and workshops and with grant proposals to support institute activity. Previously she served as an ICERM Associate Director from 2015-2020, where her focus was on the Institute's mentoring and professional development programs for students and postdoctoral fellows. 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.

Benoit Pausader is a Professor of Mathematics at Brown University and a co-PI on the ICERM grant. Benoit received his Ph.D. from the University of Cergy-Pontoise. He has held appointments at New York University, the Centre National de la Recherche Scientifique in France, and at Princeton. His current position at Brown marks his second appointment to the Brown faculty; from 2008-2011 he was appointed as a Tamarkin Assistant Professor. Benoit studies partial differential equations, especially equations coming from physics such as the nonlinear Schrodinger equation, the Euler-Maxwell system, the Water Wave system. He has been the recipient of two grants from the National Science Foundation, was named a Sloan Research Fellow in Mathematics in 2014 and a Simons Fellow in 2021.

Jill Pipher is the Elisha Benjamin Andrews Professor of Mathematics at Brown University and ICERM's founding Director Emerita. She is Brown University's Vice President for Research. Jill 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, was a National Women's History Month 2013 Honoree, and also served as president of the American Mathematical Society from 2019-2020. She was honored to deliver the 2014 ICM lecture, and the 2016 Brown University Presidential Faculty Award lecture. Jill is a Fellow of the American Mathematical Society, a SIAM Fellow, and a member of the American Academy of Arts and Sciences.

Kavita Ramanan is the Roland George Dwight Richardson University Professor of Applied Mathematics at Brown University. She served as Deputy Director of ICERM in 2020, and is currently an Associate Director. Kavita works on probability theory, stochastic processes and their applications. She has made fundamental contributions to the study of reflected processes, large deviations theory, high-dimensional probability and applications to asymptotic convex geometry. She has also developed novel mathematical frameworks for the analysis of stochastic networks, Markov random fields and interacting particle systems, which arise as models in a variety of fields ranging from operations research and engineering to statistical physics and neuroscience. Her work combines tools from several fields including discrete probability, stochastic analysis and partial differential equations. She also has four patents to her name. Kavita is an elected fellow of multiple societies including the AMS, SIAM and AAAS. She has received several honors for her research. She was awarded the Erlang prize in 2006 for "outstanding contributions to applied probability" by the INFORMS Applied Probability Society, and a Medallion from the Institute of Mathematical Sciences in 2015. She was a recipient of a Simons Fellowship in 2018, a Guggenheim Fellowship in 2020, a Distinguished Alumna Award from IIT Bombay in 2020, the Newton award in 2020 from the Department of Defense for "transformative ideas" during the COVID-19 pandemic, and a Distinguished Research

Achievement Award from Brown University in 2021. She was also named a member of the American Academy of Arts and Sciences in 2021.

Bjorn Sandstede is Alumni-Alumnae University Professor of Applied Mathematics, the Department Chair of the Division of Applied Mathematics, 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.

Jenna Sousa, Assistant Director of Programs and Operations, hired May 2014: reports to the Director. Jenna has 15+ years experience in higher education and was in student affairs before coming to ICERM. Provides project management and logistical oversight for ICERM's complex portfolio of research programs and events. This includes the oversight of all applications, invitations, housing, program schedules, special events, and exit surveys. Manages the event staff. She also is responsible for working closely with Brown University for upkeep/maintenance of the physical space at ICERM.

Ulrica Wilson is a Professor of Mathematics at Morehouse College. As ICERM's Associate Director for 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 120-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. The goal is to provide participants with a wide variety of tools to experiment with and allow them to sample options that may not be otherwise familiar in order to maximize potential avenues for research. ICERM's IT team works with program organizers to tailor technical offerings to support their vision.

Work Stations

ICERM provides virtual desktop systems to all semester program participants using a browser-based noVNC connection to the Center for Computation and Visualization. The host operating system is Redhat Linux Server, and the guests use Redhat Linux workstation. Most visitors to ICERM bring their own endpoint devices. ICERM supplies monitors, keyboards and mice for each desk. The IT group maintains a small pool of laptops available for participant use on a temporary basis, as well as an array of cables, connectors and adapters.

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. The majority of the applications provided to users will leverage existing Brown license agreements.

Web Based Tools

ICERM provides an evolving suite of web-based tools for collaboration and to assist research. ICERM uses Zoom Meeting to facilitate virtual workshops and the software is available for smaller presentations and participant working groups. They also have access to a dedicated Slack workspace for text-based messaging. ICERM offers participants licensed access to Overleaf, a collaborative web based LaTeX editor. Access to Jupyter notebooks and CoCalc are available on request.

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. The room is Zoom-capable to facilitate hybrid in-person/remote activities. A smaller meeting room is equipped with a Zoom video conferencing system and includes a digital media projection system. A seminar room on the 10th floor provides multimedia presentation capability and is also Zoom capable. ICERM also has an auxiliary portable AV system to make use of large spaces without integrated AV equipment. 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 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. It collects demographic, financial, and scheduling data for all ICERM visitors. External-facing features include our application and organizer information systems. ICERM public calendars, webpages, video archives, and publication listings refer to data held in Cube.

ORCID iD

ICERM collects ORCID iDs from NSF-funded participants. The following message is conveyed: In order for the NSF's Division of Mathematical Sciences to effectively evaluate math institutes, it requires that funded participants provide their Open Researcher and Contributor ID (ORCID) identifier. Only those participants who furnish their ID to ICERM may be supported with award funds.

Brown Computing Resources

ICERM participants are invited 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 exploratory access accounts to all long-term participants and to workshop participants on an as needed basis with approval from the Director. Accounts can be upgraded to premium level with access to higher resource limits upon request and 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.

APPENDICES

Appendix A: Fall 2022 Semester Program and Workshop Participant Lists

Appendix B: Spring 2023 Semester Program and Workshop Participant Lists

Appendix C: 2022-2023 Topical Workshops: Participant Lists

Appendix D: 2022 Extended Program: Participant Lists

Appendix E: Minutes from Board of Trustees Meeting

Appendix F: Minutes from Scientific Advisory Board Meetings

Appendix G: Minutes from Education Advisory Board Meeting

Appendix H: MIDs Meeting Minutes

Appendix I: Survey Summaries May 1, 2022-April 30, 2023

Appendix J: Publications since last ICERM report

Appendix K: ICERM Participant Data Report (NSF Required)